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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Crops Research Division serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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The increase in the volume of pertinent material offered for publication in the Plant Disease Reporter has made it necessary to limit the subject matter and the length of articles accepted. The subject matter should emphasize new things in plant pathology, such as new records of disease occurrence, serious outbreaks and epidemics, conditions affecting development of plant diseases, techniques of investigation including instrumentation, new discoveries in control including new materials and their evaluation. Manuscripts will be limited to 15 double-spaced typed pages. Insofar as possible, material should be presented as graphs rather than tables. Papers cannot be accepted for publication that report routine control experiments, reviews, bibliographies without annotation, results of routine surveys, mere summaries or lists of plant diseases. By following this procedure we hope to continue publishing all articles promptly.

Paul R. Miller

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ABSORPTION AND TRANSLOCATION OF THE F-17 ANTIRUST COMPLEX BY BEAN PLANTS AND SUBSEQUENT EFFECT ON THE RUST FUNGUS, UROMYCES PHASEOLI TYPICA

J. W. Mitchell, B. C. Smale, E. J. Daly, W. H. Preston, Jr.,[1]
T. G. Pridham, and E. S. Sharpe[2]

Summary

Bean rust was controlled under field conditions with four applications of an aqueous spray mixture containing 1100 ppm of the solids obtained from a Streptomyces cinnamomeus forma azacoluta Pridham et al. culture filtrate. The young plants naturally infected and showing marked rust symptoms at the time of the first spray recovered, grew vigorously and produced fruits. Comparable untreated plants failed to grow noticeably and did not fruit. Under field conditions of cloudy weather and relatively frequent rain, one application of an aqueous mixture containing about 1100 ppm of the dry solids from the culture filtrate reduced the disease in young field-grown plants by 99 percent even though application of the mixture was delayed for 35 hours after inoculation. About 10 times this concentration was required, however, to produce an equal effect during a period of relatively clear, dry weather. The therapeutic effect of partially purified filtrate solids was 10 to 20 times that of the unpurified solids under field conditions. Antirust complex in this filtrate was shown to be absorbed by leaves, stems and roots of young bean plants. Stem translocation was mainly upward through the plant and in a proximal to distal direction in leaves. Under greenhouse conditions, application of the culture filtrate to the upper surfaces of leaves 4 days after inoculation of the lower surfaces greatly reduced the number of pustules and almost eliminated the liberation of spores. Both the crude and partially purified preparations exhibited marked protective properties in addition to their therapeutic effects. The potency of the crude solids stored for a year in dry air at room temperature has not decreased detectably.

INTRODUCTION

Pridham et al. (3, 4) reported methods of preparing a culture filtrate of Streptomyces cinnamomeus forma azacoluta Pridham et al. that contains antibiotic factors known as "the F-17 mixture." The filtrate containing these factors is relatively effective in suppressing pustule development in plants infected with bean rust in the greenhouse. Leukel and Mitchell (1) found that solids from the culture filtrate markedly reduced the number of smutted heads of field-grown sorgo and kafir groups of sorghum when the dried antibiotic mixture was dusted on seeds of such plants infested with spores of covered kernel smut (Sphacelotheca sorghi).

In the present investigation the ability of bean plants to absorb and translocate the antirust complex of this filtrate was studied under greenhouse conditions. In addition, the effectiveness of unpurified and partially purified preparations of the complex as a therapeutant against bean rust was tested to some extent under field conditions.

The F-17 culture-liquor filtrate or the dried crude solids of the filtrate is a mixture of antibiotics (4). Chemical investigations and other studies have shown that it contains at least four antibiotic substances: factor A, which is active against Sarcina lutea Schroet; duramycin, previously represented as factor B; factor C, which has marked antifungal activity; and the

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anti-bean rust complex. Although all four factors have been partially purified, only duramycin has been obtained in pure condition (6). Duramycin has also been studied in regard to its spectrum of microbial antagonism (7).

METHODS

Inoculation: The primary leaves of bean plants (Pinto variety) were inoculated by painting their under surfaces with a suspension of rust uredospores. The uredospores were collected at intervals of approximately 3 weeks from rust-infected plants grown in the greenhouse. The spores were stored at -5 to -10° F and, when needed, suspensions were made by mixing 10 mg with one drop of Tween 20 and then adding 20 ml of tap water. The suspension was stirred with a magnetic stirrer during inoculation to insure uniform application of the spores.

The inoculated plants were immediately placed in moist air at 65° to 75° F and illuminated by fluorescent lights for 10 hours per day. About 24 hours later the plants were moved to a greenhouse or to the field.

Application of F-17 to Leaves, Stems and Roots: Full-strength culture filtrate (16 mg of solids per ml) was used in most experiments designed to study absorption and translocation of F-17. The filtrate was applied to the surfaces of stems and leaves by saturating the cotton on the end of a medical applicator stick with the mixture. The swab was then rolled over the surface of that part of the plant to be treated. The amount applied was sufficient to wet thoroughly this area of the plant. Used full strength the culture filtrate readily wetted the leaves, but when diluted it lost this characteristic. Sufficient Tween 20 was, therefore, added to diluted mixtures to make a final concentration of 0.1 percent of the wetting agent.

Root applications of F-17 were made under greenhouse conditions by pouring the full-strength culture filtrate onto the surface of soil around the roots of the potted plants, and the rate of application was calculated as pounds of the solids per acre.

Disease Rating: Disease severity was estimated by pustule counts, generally 10 to 12 days after inoculation. Ten to 12 leaves were removed from controls and from plants of each treated group. Pustules on these leaves were counted by transmitted light so that both immature and mature ones were included.

Procedures in Field Experiments: Bean seeds of the Pinto variety were planted in composted soil in 3-inch clay pots and partially germinated in a greenhouse. When the young plants had just broken the surface of the soil, the pots were moved to a field and submerged in the soil without disturbing the plants so that their subsequent growth occurred under field conditions. When the primary leaves were approximately 2 to 2.5 inches across and the first trifoliate leaves were beginning to unfold, the plants, still in the pots, were returned to the greenhouse, where they were thinned to one per pot and the primary leaves were inoculated as previously described.

Twenty-four hours later the plants were removed from the pots, without disturbing the soil around their roots, and immediately planted in the field where they remained for the remainder of the experiment. A reconstituted solution of filtrate solids and the partially purified preparation were used in these field tests to compare their effectiveness against bean rust.

RESULTS AND CONCLUSIONS

Absorption and Translocation of the Antirust Complex of Crude F-17 by Leaves: In preliminary experiments in a greenhouse, symptoms were completely suppressed and the plants showed no ill effects from treatment with the culture filtrate applied to the inoculated surfaces of primary leaves at 1/16 of its original strength. Application of full strength crude filtrate to limited areas of leaves inoculated in other limited areas showed that the antirust complex of F-17 was absorbed and translocated from proximal to distal portions of the leaves but not in the opposite direction in detectable amounts. Furthermore, this complex was not translocated out of the leaves in sufficient amounts to reduce symptom formation in nearby leaves. Pustules failed to develop when the full strength filtrate was placed on the upper surface of the leaves and the lower surfaces were immediately inoculated (Table 1). The antirust complex in the undiluted filtrate greatly reduced pustule formation even when the lower surfaces of the leaves were inoculated and the fungus was allowed to develop for 4 days before the filtrate was applied to the uninoculated upper surfaces. The number of spores liberated was also greatly

reduced by this delayed application of F-17.

These data indicate that the antirust complex in crude F-17, when applied to upper surfaces of leaves, was absorbed and moved into that part of the leaf occupied by the fungus in sufficient amounts to prevent pustule and spore formation or greatly limit them. Leaf applications at the time of inoculation or 1 to 4 days after inoculation were relatively effective.

Absorption and Translocation of the Antirust Complex of Crude F-17 by Stems: When the stems (hypocotyls and first internodes) of bean plants in a greenhouse were painted with full-strength F-17 and the primary leaves immediately inoculated, the antibiotic complex in the filtrate was absorbed and translocated upward to the primary leaves where pustule formation was practically eliminated (Table 1). Production of spores by the fungus in these primary leaves was also essentially eliminated (99 percent reduction) when the filtrate was applied on the day of inoculation. Similar treatments applied up to 2 days before or 1 day after inoculation were also highly effective, especially in suppressing spore production. Stem treatment was less effective in reducing the number of pustules, however, when applied 2 or more days after the leaves were inoculated.

Table 1. Effect of the antirust complex of crude F-17 on pustule formation and spore production by the bean rust fungus growing in primary leaves of Pinto bean plants[a].

Day of treatment[b]	Percentage reduction in number pustules formed			Percentage reduction in weight of spores liberated		
	Leaf[c] treatment	Stem[c] treatment	Root[d] treatment	Leaf treatment	Stem treatment	Root treatment
-4			75			96
-2		56	58		92	84
-1		93	24		99	81
0	100	99	0	100	100	63
+1	98	94	0	100	99	43
+2	86	0	0	99	43	6
+3	87	0	0	99	62	14
+4	72	0	0	99	34	0
+5	13	0		58	0	
+6	0	0		58	7	
+7	0			50		

[a]Figures represent average percentage that the treatment reduced the result below that obtained with untreated plants.

[b]Day of treatment in relation to time of inoculation, which is designated as 0.

[c]Dried filtrate solids were mixed with sufficient water to reproduce the original concentration of the culture filtrate; then this mixture was painted on the plant.

[d]Water mixture of dried filtrate solids was placed on soil at rate of 160 pounds of the solids per acre.

Absorption of the F-17 Antirust Complex from Soil and Its Subsequent Translocation: Compared with foliar applications of commercial fungicides, relatively large amounts of the crude F-17 filtrate solids had to be applied to soil to suppress symptoms in inoculated primary leaves. Pustule formation was reduced, however, by about 75 percent when the solids were applied to the soil at the rate of 160 pounds per acre 4 days prior to inoculation, and this treatment reduced spore production by 96 percent (Table 1). The general appearance of the treated plants was not visibly different from that of the uninoculated, untreated ones. Soil applications made immediately prior to or shortly after inoculation were relatively ineffective in reducing pustule formation, but somewhat effective in reducing spore liberation. These results indicate that some time may have been required for the antirust complex in F-17 to penetrate the soil and be absorbed and translocated upward by the plants.

Effect of Absorbed and Translocated Antirust Complex of Crude F-17 on Infectivity of Rust Spores: Several experiments were carried out in a greenhouse to learn whether spores liberated from plants treated with crude F-17 possessed infectivity equal to that of spores liberated from untreated plants. These experiments included soil and leaf treatments before and after

inoculation and the application of various amounts of the antibiotic mixture.

Infectivity of mature spores produced on treated plants was not consistently less than that of mature spores on untreated plants. There was some evidence, however, that the rate of maturation of the spores was reduced by crude F-17. Further research is needed before definite conclusions can be drawn regarding the effect of crude F-17 on the infectivity of rust spores.

Effectiveness of Crude F-17 Applied to Field-Grown Plants: As would be expected, crude F-17 was less effective in the field than in the greenhouse. Approximately 1125 ppm was required for field control of the rust while from 125 to 375 ppm was required to produce a similar effect in the greenhouse. In addition, the effectiveness of the crude F-17 in the field depended upon the weather that prevailed. Antirust complex of crude F-17 was about 10 times as effective when applied to infected plants during a period of frequent rain and cloudy days as when applied during sunny, dry weather (Table 2). Similar effects of moisture on the effectiveness of antibiotics have been observed by other investigators (2, 5).

Table 2. Influence of environmental conditions on effectiveness of crude F-17. Antibiotic preparation applied under field conditions to upper surfaces of leaves 35 hours after inoculation. Figures represent average percentage reduction in number of pustules that developed per leaf 7 days after inoculation.

Environmental conditions	Concentration (ppm) of crude F-17				
	125	375	1125	3375	11,125
Rain, low light intensity	38.0	87.8	99.6	100	
Dry, high light intensity		34.0	69.3	81.7	94.9

Effectiveness of Crude F-17 Compared with that of Partially Purified F-17: Tested over a concentration range of approximately 100 to 11,000 ppm under field conditions, partially purified F-17 proved to be 10 to 20 times as effective as the crude F-17 when used to eradicate bean rust. Use of the partially purified F-17 resulted in 91.8 percent suppression of pustule development when the mixture was applied at 375 ppm to the upper surface of bean leaves 35 hours after inoculation of the lower surfaces (Table 3). The weather during these tests was clear and dry.

Table 3. Comparison of crude F-17 and partially purified F-17 under field conditions. Preparations were applied to the upper surface of the primary leaves 35 hours after inoculation. Figures represent average percentage reduction in number of pustules that developed per leaf 7 days after inoculation.

Antibiotic preparation	Concentration (ppm)				
	125	375	1125	3375	11,125
Crude F-17		34.0	69.3	81.7	94.9
Partially purified F-17	66.8	91.8	99.0	99.8	

Effectiveness of Crude and Partially Purified F-17 Applied Before, at the Time of, and After Inoculation: Crude F-17 (1125 ppm) reduced the number of pustules in artificially inoculated primary leaves of bean plants grown in the field by approximately 80 percent when applied as much as 32 hours prior to inoculation. Under the same environmental conditions, partially purified F-17 applied in smaller amounts (375 ppm) reduced the number of pustules by 96 percent (Table 4). These results indicate that both the crude and the partially purified F-17 possessed relatively marked protective properties against bean rust in the field. Application of the preparations following inoculation showed that the therapeutic effect of both preparations under field conditions remained relatively high when the applications were made no later than about 48 hours after infection.

Table 4. Protective and therapeutic effects of crude F-17 and of partially purified F-17 when the antibiotic preparations were applied at different intervals before and after inoculation. Figures represent average percentage reduction in number of pustules that developed per leaf 7 days after inoculation.

Antibiotic preparation	Treatment in relation to time of inoculation			
	Hours before inoculation		Hours after inoculation	
	32	8	40	88
Crude F-17 (1125 ppm)	79.6	85.5	79.4	32.2
Partially purified F-17 (375 ppm)	96.4	96.2	71.7	23.7

Effectiveness of Crude F-17 and Partially Purified F-17 When Applied in Measured Amounts to the Upper, Lower, and Both Surfaces of Leaves: Both crude and partially purified F-17 were effective as therapeutants when applied to the upper, lower or both surfaces of primary leaves of field-grown bean plants. Forty-five micrograms of the crude F-17 was applied to the upper surface of each leaf or to the lower surface of each leaf. When crude F-17 was applied to both surfaces of individual leaves, a total of 90 micrograms was used. With partially purified F-17, 15 micrograms was applied to each surface or a total of 30 micrograms when both surfaces of each leaf were treated (Table 5). There was no evidence that more of the antibiotic was absorbed when applied to the lower surface than when applied to the upper surface of these leaves. The efficacy of both the crude and the partially purified F-17 was increased, however, when both sides of the leaves were treated. Leaves used in these experiments were infected as previously described and the fungus allowed to grow for approximately 35 hours before the different treatments were made.

Table 5. Therapeutic effect of crude F-17 and partially purified F-17 when applied in measured amounts[a] to the upper, lower and both surfaces of bean leaves 35 hours after the leaves were infected with the bean rust organism. Figures represent average percentage reduction in number of pustules that developed per leaf 7 days after inoculation.

Antibiotic preparation	Position of treatment		
	Upper surface	Lower surface	Upper and lower surfaces
Crude F-17 (1125 ppm)	70.0	65.6	98.0
Partially purified F-17 (375 ppm)	95.9	95.2	99.4

[a]Volume of each preparation applied was 0.04 ml where either upper or lower leaf surface was treated and 0.08 ml where both surfaces were treated.

Effect of Repeated Application of Crude F-17 on Rust: Starting with young bean plants heavily infected with rust (average of 318 pustules per primary leaf), repeated applications of crude F-17 at a concentration of 1125 ppm effectively controlled the disease under field conditions and the treated plants grew vigorously and produced flowers. In contrast, comparable unsprayed plants became so heavily infected with rust that they were unable to grow noticeably and failed to bloom. At bloom, the treated plants weighed four times as much as the untreated ones on a fresh-weight basis.

The plants became naturally infected with bean rust at an early stage in their development. The primary leaves contained many open pustules when the first trifoliate leaf was just beginning to unfold. At this stage, the plants were sprayed with a mixture containing 1125 ppm of crude F-17 and 0.1 percent of Tween 20. The plants experienced rain on the first, fifth and twelfth days following application of this initial spray. The spray was applied again after each rain. A total of four applications was therefore made during the experiment which was terminated on the nineteenth day when the sprayed plants began to bloom. Pustule counts made on

carefully selected, fully developed trifoliate leaves collected on the fifth, twelfth and nineteenth days showed that the number of pustules per square cm of leaf had been reduced 96.6, 100 and 75.8 percent, respectively, below the number that existed per square centimeter of leaf at the beginning of the experiment.

Stability of the Antirust Complex in F-17 Stored As a Liquid and As Dry Solids: The unpurified dry solids from the culture filtrate were very hygroscopic. Stored in a stoppered bottle and the bottle over calcium chloride at 40° F, the dried solids continued to show full potency for 3 years. The dried solids also continued to show full potency after storage at room temperature for a year in sealed tubes containing dry air or nitrogen. The culture filtrate itself and the unprotected dry solids lost their effectiveness, however, within a week or 10 days when stored at toom temperature.

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UNITED STATES DEPARTMENT OF AGRICULTURE, CROPS RESEARCH DIVISION, BELTSVILLE, MARYLAND AND NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION, PEORIA, ILLINOIS

A COMPARISON OF THE AMINO ACID CONTENT OF BEANS PRODUCED FROM HEALTHY AND FUSARIUM ROOT ROT INFECTED PLANTS[1]

Yet-Oy Chang, Charles W. McAnelly, and John R. Vaughn[2]

Summary

The amino acid content of dry beans produced from healthy and Fusarium root rot infected plants was determined and compared.

On a dry-weight basis the beans produced from healthy plants contained more crude protein and as much or more of the 10 amino acids considered than did those from infected plants. Calculated on a 16 percent nitrogen basis, the histidine, iso-leucine, leucine, lysine, phenylalanine, threonine, and valine content of beans from infected plants was greater, but the methionine content was less.

INTRODUCTION

Dry beans are one of the more important crops grown in the Western United States. Root rots are found in beans throughout this region. In many instances severe damage is caused by these rots. Little is known of their effect on the amino acid content of beans produced from infected plants. A preliminary study was undertaken to determine the extent to which dry beans produced by plants infected with Fusarium solani (Mart.) Appel & Wr. f. phaseoli (Burk.) Snyd. & Hans. differed in their amino acid content from those of healthy plants.

PROCEDURE

Beans of the Great Northern variety were grown in steam-sterilized soil in a greenhouse bench. The bench was divided into four equal sections by aluminum foil to prevent contamination from one compartment to the other. Two alternate sections were inoculated with an aqueous mixture of four isolates of Fusaria known to be strong bean root-rot inciters. Beans were planted in three rows, one through the center of each plot and the other two 24 inches on each side of the first. After emergence these rows were thinned to 30 plants per plot which were allowed to grow to maturity. The beans were harvested and thrashed. The ones from the infected plants were placed together as were those from the healthy plants.

Each lot of beans was thoroughly mixed and from each a 100-gram sample was taken and ground into a fine powder. A 2-gram sample of each of these was used to determine the nitrogen content by the Kjeldahl method. Likewise, a 2-gram sample was taken for the quantitative determination of 10 amino acids: that is, arginine, histidine, iso-leucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. These were determined microbiologically by the method of Dunn et al. (1, 2). Three determinations of each amino acid were made.

RESULTS

Dry beans produced by healthy plants were found to contain 32.25 percent crude protein, and an equal amount of beans produced by Fusarium infected plants yielded 28.31 percent of this material.

On the dry-weight basis beans produced by healthy plants contained more arginine, leucine, lysine, methionine, phenylalanine, threonine, and valine. The amounts of histidine, iso-leucine, and tryptophan were about the same as those from infected beans. (Table 1.)

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[1] Published with approval of the Director, Wyoming Agricultural Experiment Station, Laramie, Wyoming, as Journal Paper No. 128.

[2] Assistant Home Economist, Assistant Plant Pathologist, and Assistant Director of Wyoming Agricultural Experiment Station, respectively.

Table 1. Average amino acid content of beans produced from healthy and Fusarium-infected plants expressed in percentage of total dry weight.

	Argi-nine	Histi-dine	Iso-leucine	Leucine	Lysine	Methi-onine	Phenyl-alanine	Thre-onine	Trypto-phan	Va-line
Healthy	2.18	0.80	1.25	2.16	1.78	0.38	1.80	1.45	0.19	1.45
Infected	1.91	0.81	1.21	1.99	1.60	0.22	1.70	1.33	0.18	1.37

Calculated on a 16 percent nitrogen basis, the histidine, iso-leucine, leucine, lysine, phenylalanine, threonine, and valine contents of the beans grown from infected plants were found to be greater than those produced by healthy plants. The arginine and tryptophan content of both was about the same. The amount of methionine was found to be less in the beans from infected plants. (Table 2.)

Table 2. Average amino acid content of beans produced from healthy and Fusarium-infected plants. Calculated on a 16 percent nitrogen basis and expressed in percentage.

	Argi-nine	Histi-dine	Iso-leucine	Leucine	Lysine	Methi-onine	Phenyl-alanine	Thre-onine	Trypto-phan	Va-line
Healthy	6.75	2.48	3.87	6.69	5.51	1.17	5.58	4.49	0.59	4.83
Infected	6.74	2.85	4.27	7.02	5.64	0.77	6.00	4.69	0.63	4.83

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WYOMING AGRICULTURAL EXPERIMENT STATION, LARAMIE

THE EFFECTS OF THIAMINE AND TEMPERATURE UPON THE PIGMENTATION AND GROWTH OF BEAN WILT BACTERIA[1]

M. L. Schuster, J. P. Jones, and R. M. Sayre[2]

Summary

The effects of temperature and essential vitamins in a basal medium were studied on the cellular pigment and growth of naturally occurring yellow- and orange-colored bean wilt bacteria. Thiamine influences the pigment production of both of these organisms. The color shift in Corynebacterium flaccumfaciens (Hedges) Dowson is from cream to yellow as the thiamine concentration increases. The effect appears different from that in C. flaccumfaciens (Hedges) Dows. var. aurantiacum Schuster & Christiansen which produces either an orange, yellow or pink cell pigment depending upon the thiamine content of the medium. At thiamine concentrations which favor only moderate growth, the cell mass is pink whereas at thiamine levels well above the amount necessary to fulfill the growth requirements the pigmentation is changed to orange or yellow. Color change is not necessarily associated with the amount of growth. Low temperature (5° C) appears to inhibit production of yellow pigmentation even in amounts above optimal quantities of thiamine. Color differences at different levels of thiamine were not due to pH differences of the media. The effect of different thiamine concentrations upon the pigment color was essentially the same in the series of experiments.

The color of the cell mass of the bean wilt bacterium, Corynebacterium flaccumfaciens var. aurantiacum Schuster & Christiansen, has been shown to be differentially affected by different temperatures (3). Starr (4) has shown that Corynebacteria are rather specific in their nutritional requirements with certain nutrients affecting both growth and color of the bacteria. C. poinsettiae Starr & Pirone, a species pathogenic to Poinsettia sp., has been found to have essentially the same nutritional requirements as the yellow-colored bean wilt bacterium, C. flaccumfaciens (Hedges) Dowson (4). In the studies on nutritive requirements for growth of the Corynebacteria, Starr (4) and Starr and Saperstein (5) reported on the relationship between the quantity of thiamine added to the culture medium and the growth and pigmentation of C. poinsettiae. At thiamine concentrations which support only moderate growth the cell mass is a brilliant pink, whereas at thiamine levels well above the quantity required to satisfy the growth requirements the color shift is lightened to an orange or yellow.

Braun (1) has shown that thiamine influences pigment production in C. michiganense (E. F. Smith) Jensen and appears different from that of C. poinsettiae since the color shift in the tomato pathogen is from cream to yellow as the thiamine concentration increases. The report (4) on the nutritive requirements of C. flaccumfaciens did not include any reference to the effect of thiamine concentrations on color changes. With the discovery of the orange-colored variety of this bean wilt species, it was decided to investigate further the effects of essential vitamins and temperature on the growth and pigmentation of the yellow- and orange-colored bean wilt bacteria.

MATERIALS AND METHODS

The orange-colored variety, C. flaccumfaciens var. aurantiacum, and a yellow culture (C. flaccumfaciens) of bean wilt bacteria were used in this study. The former culture was isolated from seed of field beans grown in western Nebraska and the yellow culture was obtained

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[1]Published with the approval of the Director as paper No. 940, Journal Series, Nebraska Agricultural Experiment Station.

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from Dr. W. J. Zaumeyer, Beltsville, Maryland. Both cultures were pathogenic to beans; differences in virulence could not be detected.

A preliminary experiment was designed to test the effect of varying three essential vitamins -- thiamine, biotin, and calcium pantothenate -- upon the pigmentation of the two bean wilt bacteria. A series of the basic solution was prepared in which all three vitamins were included at their optimum concentration for growth and 100 times their optimum concentrations. The vitamins were varied in all possible combinations with each other at the two concentration levels.

The basal medium in Experiment 1 and in the above preliminary test was the one determined by Starr (4) which gave optimal growth for the wilt bacteria. The medium consisted of NH_4Cl, glucose, and salts basal medium supplemented with 1 percent "vitamin free" casein hydrolysate (General Biochemicals brand) and vitamins. The vitamin supplement consisted of (in micrograms per liter) biotin 0.03, pantothenate 30, and thiamine 1. In subsequent experiments (Nos. 2 and 3) the basal medium was modified using the formula described by Starr and Saperstein (5) in which was used 1 g casein, 1 mg calcium pantothenate, and 1 μg biotin per liter of medium. In the experiments reported in this paper the thiamine concentrations were varied while the other constituents of the medium remained constant. Chemicals used to prepare the solutions were reagent grade. Water used in the formulations was triple distilled in glass. All glassware was cleaned in chromic acid solution. The temperature of the experiments was about 25° C unless otherwise indicated.

A graded series of solutions was prepared by varying the concentration of thiamine in the basic minimal solution. The thiamine concentrations were increased in multiples of ten of the basic thiamine concentration of 1 μg/liter. The highest concentration used was 1000 μg/liter. In each experiment each thiamine concentration was in duplicate (Experiment 1) or in triplicate (Experiments 2, 3). The solutions were added to 50 ml Erlenmeyer flasks in 10 ml lots in Experiment 1 and 30 ml amounts were added to 125 ml Erlenmeyer flasks in subsequent experiments. The flasks were plugged with non-absorbent cotton and autoclaved at 15 pounds' pressure for 20 minutes.

After sterilization the solutions were inoculated with the bacteria. The procedure employed was to dip an inoculating loop into a bacterial colony on a 2 percent potato-dextrose agar slant (Experiment 1) or from thiamine-free medium (Experiments 2, 3) and then transfer the bacterial cells to 1 ml of sterilized distilled water. The bacterial suspension was taken up in a sterilized capillary pipette and one drop added to each flask and incubated for 5 to 7 days at temperatures reported. The final pH of the medium at the time of growth readings was determined with a Beckman pH meter.

The growth determinations were made using different procedures. In initial experiments turbidity measurements were obtained with a photoelectric colorimeter. In subsequent experiments quantitative expressions of growth were determined by the use of dilution plate techniques or final centrifugation in graduated sedimentation tubes[3]. The latter procedure gave a direct volumetric measurement of bacterial growth. The bacterial suspension was first centrifuged for 1/2 hour at about 500 rpm in 50 ml tubes. The pellet was resuspended in 3 ml of water in graduated 3 ml tubes and centrifuged for 1/2 hour at about 1000 rpm.

The color of the bacteria was determined by the use of Ridgway's color standards (2) except where noted. Although color differences in the bacterial suspensions with the different thiamine concentrations could be detected visually, the color of the pellet after centrifugation was the criterion used in determining the pigmentation of the bacterial cell masses.

EXPERIMENTAL RESULTS

Data from the preliminary experiment indicated that of the three essential vitamins only thiamine affected the color of the two bean wilt bacteria. A very distinct color difference of the bacterial cells was noted between the media containing the two concentrations of thiamine. C. flaccumfaciens in the solutions containing thiamine concentrations of 1 μg/liter appeared light yellow while in the 100 μg/liter concentration the bacteria were dark yellow. C. flaccumfaciens var. aurantiacum appeared pink in the culture media containing the low thiamine rate and light orange at the higher rate. Slight differences in shades of color of both bacterial organisms could be detected due to changes in concentrations of biotin and/or calcium pantothenate.

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3 The narrow tip of these centrifugation tubes are graduated from 0 to 0.4 ml in 0.004 ml subdivisions; the cylindrical body is graduated from 0.5 to 3 ml in 0.1 ml subdivisions.

The results of Experiment 1 also showed that the color of the cell mass of both C. flaccumfaciens and C. flaccumfaciens var. aurantiacum was affected by a variation in the concentration of thiamine in the culture medium. As presented in Tables 1 and 2, at low thiamine concentrations the cell mass of C. flaccumfaciens var. aurantiacum was pink and at higher concentrations the pigmentation shifted to buff or yellow. A color change was also noted for C. flaccumfaciens; at thiamine concentrations of 0-1 μg/liter the colors of this organism appeared cream to light yellow and above 1 μg the bacterial cell masses shifted to a darker yellow. In both of the wilt bacteria a definite color change occurred most frequently at the 1 μg/liter concentration of thiamine.

Because growth differences of the bacteria due to varying thiamine concentration could not be accurately determined by turbidity measurements, other direct methods, dilution plate techniques and volumetric measurements were employed. In these tests only C. flaccumfaciens var. aurantiacum was used because the yellow-colored wilt organism began to mutate with white mutants occurring at a higher frequency. Obviously the effects of thiamine on pigmentation could not be properly evaluated under such circumstances. With respect to the other strain, different colored mutants were not selected on the media containing different levels of thiamine. In conjunction with these experiments the pH of the solution was apparently not a factor in the color change or growth of the bacteria. Therefore pH readings were discontinued after the initial experiments.

In the basal culture medium described by Starr and Saperstein (5), the growth differences of C. flaccumfaciens var. aurantiacum due to variation levels of thiamine were more apparent than with the culture medium employed in the initial test. The dilution method used in determining the amount of growth was found most practical for counts in the plates to which the 10^{-5} dilutions of bacteria were added. It was quite apparent that in the absence of thiamine the poorest growth resulted (Table 2). The increase in number of viable cells was evident with the three highest rates of thiamine yielding about the same number of cells per unit volume of medium.

In Experiment 2 the definite color change of the bacteria was evident above the 1 μg/liter concentration of thiamine. The pigmentation was not necessarily correlated with amount of growth.

Temperature affects both the amount of growth and the effect of thiamine concentration of pigmentation of the bacterium (Table 3). The three temperatures employed included 25° C which is about optimum and 5° and 35° C. The color of the cell masses was the same for all three temperatures in the absence of thiamine. However, at the 5° temperature the color shift never reached the yellow as was evident at the higher temperatures. Similarly the growth rate at 5° was very low at all levels of thiamine. A more sudden response to low and medium levels of thiamine was evident at 25° than at the highest temperature.

Temperature affects pigmentation of C. flaccumfaciens var. aurantiacum. In the presence of thiamine the basic orange color is predominant at 5° C whereas at 25° and 35° at higher thiamine levels a yellow coloration appears. Low temperature either inhibits or decreases the rate of the production of pigments that impart a yellow color to the bacterial cell masses, whereas at the higher temperatures (25° and 35°) the development of these pigments is not prevented. On the basis of the growth data at the 5° temperature it may be that coloration is correlated with cell mass but only over a limited range of conditions. However, in most of the experiments the contrary was found to be true. In fact the cell masses at thiamine levels of 0.1 μg/liter at 25° and 35° are as great as at higher thiamine levels, but the coloration is different.

DISCUSSION

The bean wilt bacteria, C. flaccumfaciens and C. flaccumfaciens var. aurantiacum, are affected by thiamine concentrations in the culture substrates. Pigmentation of the bacterial cell mass at low levels (1.0 μg/liter) or in the absence of thiamine in the substrate tends to be pink for the orange-colored wilt organism and then shifts to an orange and finally to a yellow coloration as the thiamine concentrations are increased from 10 to 1000 μg/liter. The effect of thiamine levels for the naturally occurring yellow bean wilt bacterium was a change from cream or light yellow at low (0.01-0.1 μg/liter) concentrations to yellow at high (1-1000 μg/liter) concentrations of thiamine. In the related species, C. michiganense, thiamine was observed by Braun (1) to affect pigmentation in a similar manner with a color shift from cream to yellow. Perhaps similar carotenoid pigments are present in the two species. The major pigments in C. michiganense have been shown by Saperstein, Starr and Filfus (6) to be caroten-

Table 1. The effect of thiamine concentration upon the pigmentation and growth of C. flaccumfaciens and C. flaccumfaciens var. aurantiacum. Experiment 1.

Thiamine µg/liter	C. flaccumfaciens: Pigment color	C. flaccumfaciens: Final[a] pH	C. flaccumfaciens var. aurantiacum: Pigment color	C. flaccumfaciens var. aurantiacum: Final[a] pH
0.00	Cream	5.8	Jaspar pink	5.7
0.01	Cream	5.8	Jaspar pink	5.6
0.10	Cream	5.6	Jaspar pink	5.6
1.00	Straw yellow	5.3	Coral pink	5.5
10.00	Mustard yellow	5.3	Apricot buff	5.5
100.00	Mustard yellow	5.3	Apricot buff	5.5
1000.00	Mustard yellow	5.3	Apricot buff	5.5

[a] Determined by Beckman pH meter.

Table 2. Effect of thiamine levels of pigmentation and growth of C. flaccumfaciens var. aurantiacum. Experiment 2.

Thiamine µg/liter	Pigment color	Dilution count[a] 10^{-5}
0.0	Shrimp pink	79
1.0	Shrimp pink	172
10.0	Capucine buff	426
100.0	Capucine yellow	402
1000.0	Capucine yellow	436

[a] Average of duplicates of each of three replications.

Table 3. Effect of thiamine levels and temperature on the growth and pigmentation of C. flaccumfaciens var. aurantiacum. Experiment 3.

Thiamine µg/liter	Pigment color at temperatures ° C: 5	25	35	Growth in ml at temperatures in ° C[a]: 5	25	35
0.0	Strawberry pink	Strawberry pink	Strawberry pink	0.010	0.066	0.036
0.1	Salmon orange	Strawberry pink	Strawberry pink	0.006	0.220	0.128
1.0	Salmon orange	Capucine yellow	Apricot buff	0.010	0.196	0.168
10.0	Salmon orange	Capucine yellow	Capucine yellow	0.010	0.212	0.196
100.0	Salmon orange	Capucine yellow	Capucine yellow	0.010	0.340	0.252
1000.0	Salmon orange	Deep chrome	Capucine yellow	--[b]	0.200	0.260

[a] Average from three 30 ml replications of culture medium.
[b] Not tested.

oids. The presence of carotenoids has not been ascertained in the cells of C. flaccumfaciens. Differences in color between the naturally occurring yellow culture of C. michiganense and the pink and orange mutants are qualitative changes in carotenoid pigments (6). This qualitative manifestation of pigment production in C. michiganense was correlated with thiamine requirements. The shift in pigmentation color of C. flaccumfaciens var. aurantiacum with changes in thiamine levels is comparable to that shown for C. poinsettiae. Qualitative and quantitative changes in the carotenoid pigments of C. poinsettiae were demonstrated when the level of thiamine was altered (5).

It is quite possible that the changes in carotenoid pigments in the bean wilt bacteria may be comparable to those found in C. poinsettiae and C. michiganense. C. flaccumfaciens, the naturally occurring yellow bean wilt bacterium, may be similar in its reaction to thiamine on carotenoid production to the yellow strain of C. michiganense. Similarly C. flaccumfaciens var. aurantiacum which also occurs naturally may prove to possess the same carotenoid pigments as C. poinsettiae and the orange and pink mutants of C. michiganense as the thiamine levels are altered. Preliminary studies are being made currently to ascertain the thiamine effects on the pigments present in the cells of the bean wilt bacteria which should substantiate or disprove these assumptions. The color of the bacterial cells may prove to be due to carotenoid pigments. It is highly probable that the pigments of these bacteria will be affected qualitatively and quantitatively by the concentration of thiamine.

The knowledge that thiamine is required for growth by the bean wilt bacteria may have practical implications. Bean varieties may vary in their thiamine content and these differences in this vitamin content could affect their reaction to the wilt-inducing pathogens. Experiments are underway to test this hypothesis by initially employing the reaction of mature seed to the bacteria. Results from these tests will dictate other experiments to determine if resistance to the wilt organisms may be correlated with low thiamine content of the host plant.

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NEBRASKA AGRICULTURAL EXPERIMENT STATION, LINCOLN

EFFECT OF SOIL FUMIGATION ON THE PREVALENCE OF SOUTHERN BLIGHT ON TOMATOES[1]

Harvey W. Rankin and J. M. Good[2]

Southern blight, caused by the fungus Sclerotium rolfsii Sacc., is one of the most destructive diseases of tomatoes, peppers, tobacco, and peanuts on the sandy soils of the Georgia Coastal Plain. Work with chemicals applied to the soil for the control of this disease has been carried on at the Georgia Coastal Plain Experiment Station for a number of years. In 1958, two nematocides, D-D and Nemagon, were included in an experiment to determine whether nematodes may be associated with S. rolfsii in increasing the severity of southern blight. The unexpectedly striking and consistent increase of southern blight in every replicate where D-D was used is of interest and merits note.

Partyka and Mai[3] noted that "treating field soil with a nematocide, D-D mixture, increased the incidence of drop of lettuce caused by Sclerotinia sclerotiorum (Lib.) d By." They also reported that increasing the dosage of D-D progressively increased the percentage of stipe production by sclerotia but decreased the percentage of sclerotia germinating by vegetative hyphae.

MATERIALS AND METHODS

The land selected for the test was Tifton sandy loam naturally infested with Sclerotium rolfsii and nematodes, principally Meloidogyne incognita. Rutgers tomatoes, transplanted the middle of April, were used as test plants, and fertilization and cultivation practices were normal for the crop. Eight treatments were included in the test and each was replicated five times in randomized blocks. Each plot consisted of two rows 38 inches apart and 60 feet long. The plots were separated by 76-inch middles. The tomato plants were set 3 feet apart in the rows, giving an initial stand of 40 plants per plot. After the plants became established they were sprayed weekly, using a power sprayer, with a standard formulation of tribasic copper and DDD[4].

Row and broadcast applications of Vapam were made on January 28 and February 28, 1958. Broadcast applications were injected to a depth of about 5 inches with tractor-drawn, pressurized equipment, with the injection chisels spaced 6 inches apart. Row applications of Vapam were injected to a depth of 8 inches with tractor-drawn, gravity-flow equipment having two chisels per row. Nemagon EC-2 (diluted with water) and D-D were applied with the equipment used in applying Vapam in rows except that one chisel per row was used.

The injection rows were covered by disc tiller plows and they were immediately packed with a rolling packer. PCNB was applied around the plants a few days after transplanting.

The number of plants that died from causes other than southern blight was recorded for each plot. As the weather became warm and S. rolfsii became active, all plants killed by it were recorded and pulled up. This practice was repeated at weekly intervals to the end of the picking season. The number of tomatoes harvested from each plot was recorded. At the end of the picking season all surviving plants were removed from each plot and the rootknot index was determined for each treatment.

RESULTS AND DISCUSSION

The data were statistically analyzed and are summarized in Table 1.

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[1] Cooperative investigation between the University of Georgia College of Agriculture Experiment Stations, Georgia Coastal Plain Experiment Station, and The United States Department of Agriculture, Agricultural Research Service, Crops Research Division, Tifton, Georgia. Contribution of the Department of Plant Pathology, Georgia Coastal Plain Experiment Station. Published with the approval of the Director as Journal Series Paper No. 64.

[2] Plant Pathologist, Georgia Coastal Plain Experiment Station, and Nematologist, United States Department of Agriculture, respectively.

[3] Partyka, R. E. and W. F. Mai. 1958. Nematocides in relation to sclerotial germination of Sclerotinia sclerotiorum. Phytopathology 48: 519-520.

[4] 1, 1-bis (p-chlorophenyl) -2,2-dichloroethane.

Table 1. Effects of several chemical soil treatments on tomato yield, incidence of southern blight, and root knot index.

Soil treatments	Average number of tomatoes harvested per plot	Average number plants dead from southern blight	Average root-knot index[e] (0.4)
D-D -- 10 gallons per acre in row[a]	240.4	22.4	0.36
Nemagon - 3 1/2 qts. per acre in row[b]	237.2	14.2	0.51
Check	236.0	12.2	0.80
PCNB - 1/2 pint per plant of solution at 4 pounds per 100 gallons[c]	236.0	9.8	0.85
Vapam (Row-Jan.) 8 gallons per acre[d]	257.2	12.4	0.65
Vapam (Row-Feb.) 8 gallons per acre	319.8	10.4	0.85
Vapam (Broadcast Jan.) 100 gal per acre	345.4	6.6	0.84
Vapam (Broadcast Feb.) 100 gal per acre	280.4	10.6	0.68
L.S.D. .01	80.98	5.54	
L.S.D. .05	60.03	7.07	
L.S.D. .10			0.29

a D-D (About 50% w 1,3-dichloropropene and 50% w 1,2-dichloropropane).
b Nemagon EC-2 (emulsible concentrate 50% vl, 2-dibromo-3-chloropropane).
c PCNB (75% pentachloronitrobenzene).
d Vapam (4 pounds/gallon of sodium-N-methyl dithiocarbamate dihydrate).
e 0 equals no rootknot and 4 equals maximum rootknot.

The use of Vapam and PCNB as chemical soil treatments for the control of S. rolfsii is part of a study covering several years and will not be discussed here. This report is confined to the effect of D-D on the prevalence of southern blight of tomatoes.

Analysis of the data shows that D-D, and possibly Nemagon, soil treatments increased the incidence of southern blight. The cause of the increased fungus activity cannot be stated. It cannot be said that when D-D or any other soil fumigant is used there will be a resulting increase in disease. It seems more probable that, under certain conditions, D-D, and possibly other soil fumigants, affect the biological content of the soil in such a manner that an increase or decrease of certain organisms, sometimes pathogenic, may result.

GEORGIA COASTAL PLAIN EXPERIMENT STATION AND CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, TIFTON, GEORGIA

TOMATO A NEW SUSCEPT OF GIBBERELLA ZEAE (SCHW.) PETCH

J. A. Crozier, Jr.[1] and C. W. Boothroyd[2]

A few ripe tomato fruits were found to be partly rotted when harvested in October 1957 from plants grown in a plastic greenhouse at Ithaca, New York. The rot was brownish in color and confined to cracks in the shoulders of the fruit (Fig. 1). When diseased fruits were cut open the flesh in advance of the rotted margins was found to be a deep purplish red in color (Fig. 2). Isolation from the rotted areas yielded a fungus resembling Gibberella zeae (Schw.) Petch. This fungus produced a rapid rot when introduced into both green and red tomato fruits.

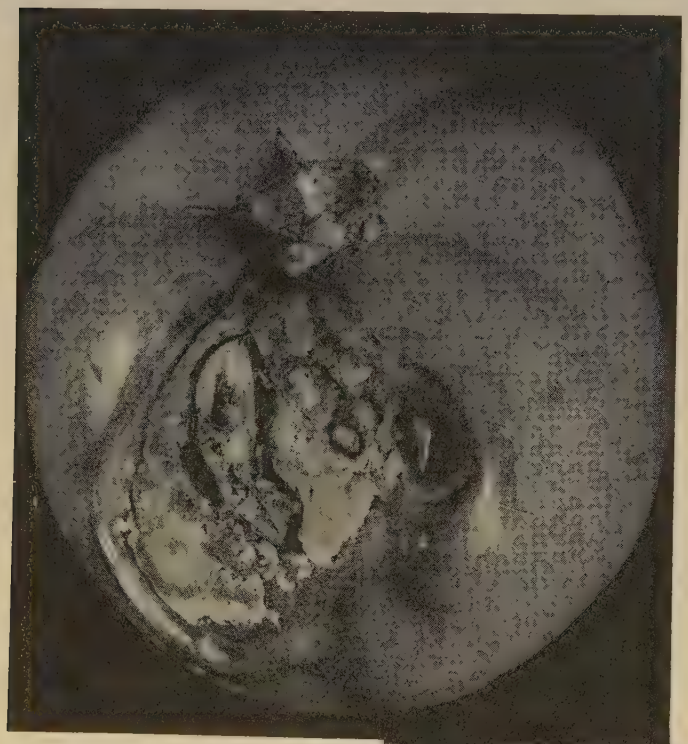

FIGURE 1. Gibberella fruit rot of greenhouse-grown tomato.

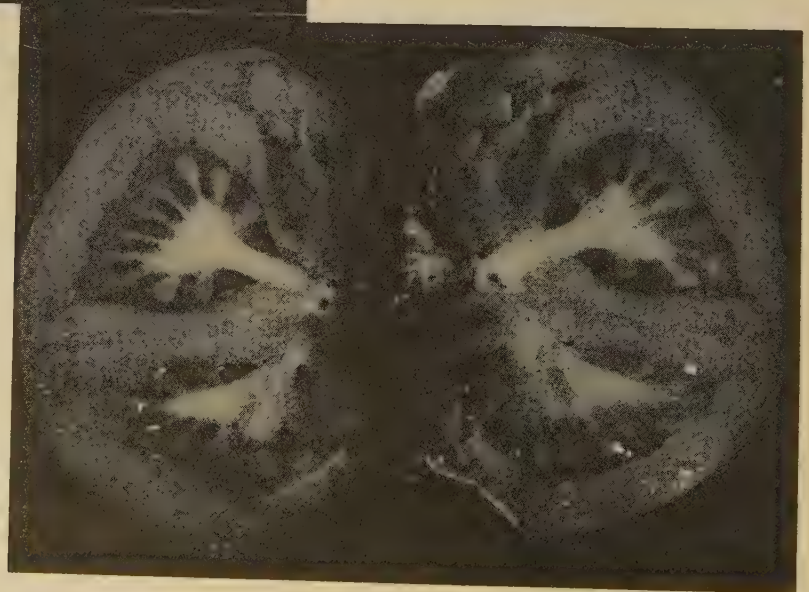

FIGURE 2. Tomato fr artificially inoculated with Gibberella zeae.

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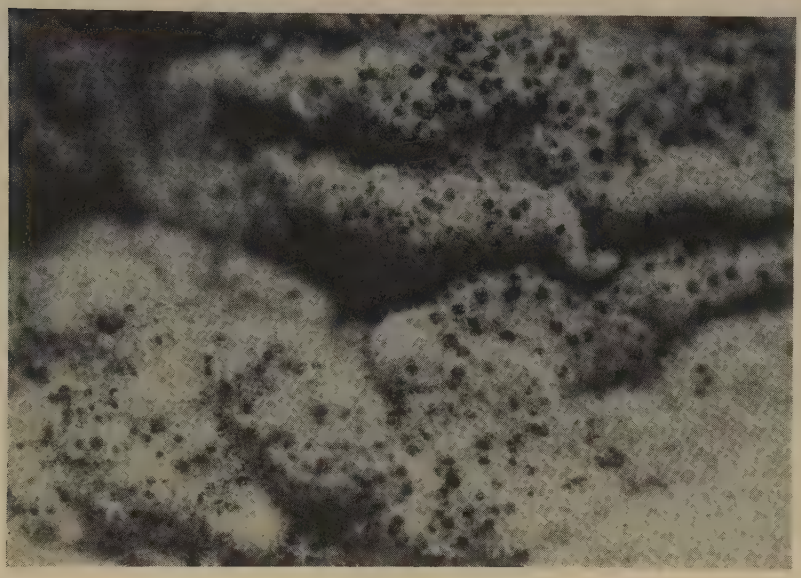

FIGURE 3. Perithecia of Gibberella zeae on surface of tomato fruit.

The rotted fruits being harvested were of the variety Marglobe, a variety with a high proportion of shoulder cracking of tomato fruits. Little, if any, rot was discovered in fruits of four crack-resistant tomato varieties being grown in the same house: Boston Comet, Comet, Trellis 22, and Crack-resistant Trellis. A single green fruit that had fallen to the ground was found rotted by a similar fungus. The rotted area was covered with pionnotes of macroconidia and many dark perithecia (Fig. 3). Asci and ascospores resembling those of G. zeae in size and shape were found in these perithecia.

The tomatoes in the plastic greenhouse were mulched with wheat straw. Both asexual and sexual stages of G. zeae were found on wheat heads in this mulch. It is believed that the Gibberella fruit rot of the Marglobe tomato variety was caused by infection initiated by spores of G. zeae carried from the wheat straw to cracked tomato fruits.

Tomato plants of crack-resistant varieties were grown in the same plastic greenhouse in 1958. Wheat straw mulch was again used but no G. zeae could be found on the straw. No Gibberella fruit rot of tomato was discovered.

CORNELL UNIVERSITY, ITHACA, NEW YORK

REACTION OF SOME CUCURBITACEAE TO ROOT-KNOT NEMATODES (MELOIDOGYNE SPP.)

Ivan J. Thomason and H. E. McKinney[1]

Summary

A number of Cucurbitaceae representing the cucumber, cantaloupe, winter melon, squash, pumpkin, and watermelon were tested for their reaction to three root-knot nematodes, Meloidogyne incognita acrita, M. javanica, and M. hapla. All varieties tested were susceptible to M. incognita acrita and M. javanica. Two populations of M. hapla were used which differed in their ability to reproduce on the cantaloupe and winter melon varieties. Some varieties tested against one population were found susceptible while other varieties tested against another population were resistant. Cucumber varieties were susceptible to the population of M. hapla used to test them. Squash varieties were tolerant-to-resistant to the M. hapla population used to test them.

Crop plants within the family Cucurbitaceae are often seriously damaged by root-knot nematodes, Meloidogyne spp. These nematodes are widely distributed in California and can build up to large numbers on susceptible hosts during the long growing season. Injury to cantaloupe, cucumber, squash, and watermelon has been observed.

The reaction of a number of Cucurbitaceae to Meloidogyne spp. was reported by Sasser (2). He found that all cucurbits tested, except the gherkin, Cucumis anguria L., were susceptible to Meloidogyne incognita (Kofoid and White, 1919) Chitwood, 1949, M. incognita acrita Chitwood, 1949, M. javanica (Treub, 1885) Chitwood, 1949, and M. arenaria (Neal, 1889) Chitwood, 1949. Gherkin was susceptible to the first two species and resistant to the last two species. Of the 12 cucurbits tested only the Jumbo Hale's Best muskmelon, Cucumis melo var. reticulatus Naud., was susceptible to the root-knot nematode M. hapla Chitwood, 1949.

All cucumber, Cucumis sativus L., varieties tested by Winstead and Sasser (3) were resistant to M. hapla and susceptible to M. incognita, M. incognita acrita, M. javanica, and M. arenaria. The two gherkin varieties tested differed in their susceptibility to different root-knot species. Gaskin and Crittenden (1) investigated the reaction of several members of the Cucurbitaceae to M. hapla. All hosts tested were resistant except Warted Hubbard squash, Cucurbita maxima Duch., Hale's Best cantaloupe, Cucumis melo L., and Marketer cucumber, which showed moderate to severe infection.

In 1955 the authors initiated tests to determine the reaction of a number of the commonly grown members of the Cucurbitaceae[2] to three root-knot nematode species occurring in California. It was hoped that nematode resistant varieties might be found which could be used directly or as sources of resistance in a breeding program.

MATERIALS AND METHODS

Single egg mass populations of the root-knot nematodes maintained on Rutgers tomato were used for inoculum. In the first test 5 grams of galled tomato roots were used as inoculum in each 6-inch clay pot and the cucurbits were seeded directly into the pots. This resulted in considerable damping-off and in subsequent tests the cucurbits were seeded in non-infested soil. When the seedlings were 2 weeks old 10,000 root-knot nematode larvae were introduced into the soil. This latter technique proved satisfactory and had the added advantage of exposing the plants to a uniform number of larvae. Six plants of each variety (three in each of two pots), were tested against each nematode species. In all tests Rutgers tomato were included as a check on the inoculum potential.

Six weeks after inoculation the roots of the plants were washed free of soil and rated for the

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[2] Seed for these tests were kindly supplied by Dr. Thomas W. Whitaker, Geneticist, U.S.D.A. Crops Research Division, La Jolla, California.

Table 1. Reaction of Cucurbitaceae to root-knot nematodes (*Meloidogyne* spp.).

Variety or Line	Susceptibility Ratings		
	M. incognita acrita	*M. javanica*	*M. hapla*
CUCUMBER			
Cucumis sativus			
Robin 40	3	4	4
Lemon	3	4	4
York State	2	4	4
Ohio MR-17	3	4	4
Pickling hybrid	3	4	4
Robin 50	3	-	-
Magnolia	3	4	3
Highmoor	3	-	-
CANTALOUPE			
Cucumis melo			
No. 5 Robinson	3	4	4
No. 6 Robinson	3	4	4
No. 450 Robinson	3	4	4
V-1 (FM)	4	4	4
Pride of Wisconsin	3	-	-
Rio Gold Robinson 1954	4	-	-
Rio Sweet Weslaco, Texas	3	4	1
Georgia 47	4	-	-
Far North	3	-	-
Purdue 44	3	4	2
Iroquois	3	4	4
Golden Gopher	3	-	-
Hale's Best	3	4	1
PM Resistant No. 45	3	-	4
SR-91	3	4	4
Roun's 45	3	-	-
Seed Breeders	3	-	-
Texas Resistant #1	3	4	4
Rocky Ford	4	4	1

Table 1. concluded

Variety or Line	Susceptibility Ratings		
	M. incognita acrita	*M. javanica*	*M. hapla*
WINTER MELONS			
Cucumis melo			
Honey Ball Green Flesh [c]	4	-	-
Honey Ball Pink Flesh [a]	4	-	-
Honey Ball Pink Flesh [b]	4	4	1
Honey Ball Pink Flesh [c]	4	-	-
Honey Dew [a]	3	3	4
Honey Dew [b]	3	-	-
Honey Dew Golden Rind	3	4	1
Honey Dew Green Flesh	3	-	-
Honey Dew (Rocky Ford)	3	-	-
Honey Rock [c]	3	-	-
Persian	4	4	4
Crenshaw	4	4	4
Pershaw	3	4	1
Honey Ball, Melogold	4	4	-
Casaba	4	4	1
WATERMELON			
Citrullus vulgaris			
Striped Klondike (wilt res.)	2	4	0
SQUASH			
Cucurbita pepo			
Black Zucchini	2	4	1
Scallop	2	4	1
Summer Crookneck	2	4	2
Table Queen (Acorn)	2	4	2
Cucurbita moschata			
Butternut	4	4	1
Cucurbita maxima			
Pink Banana	2	4	2
PUMPKIN			
Cucurbita pepo			
Connecticut Field	3	4	0

[a] Associated Seed Growers (Asgrow)
[b] FM -- Ferry Morse Seed Co.
[c] Robinson Seed Co.

severity of root-galling and the rate of nematode reproduction. Roots were examined macroscopically and with the aid of a dissecting microscope. The following rating system was used: 0 -- no infection, or if larvae entered the roots they did not develop into egg-laying females; 1 -- very light infection, or only an occasional female egg mass; 2 -- light infection with mature females and a few egg masses easily seen with the naked eye; 3 -- moderate infection with mature females and egg masses moderately abundant; and 4 -- severe infection with mature females and egg masses very abundant.

EXPERIMENTAL RESULTS

The cucurbits tested and their reactions to three root-knot nematodes are presented in Table 1. The 50 varieties tested against M. incognita acrita were susceptible. The 33 varieties tested against M. javanica proved to be susceptible also. All cucumbers were susceptible to the population of M. hapla used to test them. There was a mixed reaction of some of the cantaloupes and winter melons which was due to their being tested against two different populations of M. hapla. The watermelon and squashes were resistant to the M. hapla population used to test them.

DISCUSSION

The varieties tested were all susceptible to M. incognita acrita and M. javanica, the two species most often found injuring cucurbits in California. Relatively small numbers of plants within each variety were tested and there is a possibility that if larger numbers were tested resistant individuals might be found. However, it seems much more likely that if sources of resistance are to be found they will be found in such exotic forms as the gherkin as reported by Sasser (2) and Winstead and Sasser (3).

The mixed reaction of the cantaloupes and winter melons to the two populations of M. hapla was not surprising. Winstead and Sasser (3) reported Marketer cucumber resistant to a population of M. hapla. However, this same variety of cucumber was reported to be susceptible to a population of M. hapla used by Gaskin and Crittenden (1). Ample evidence is available for the existence of races within root-knot nematode species, and this should caution plant breeders to test potential root-knot resistant varieties against more than one population of a species.

Literature Cited

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PRESSURE INJECTION OF CHEMICALS FOR POSSIBLE SYSTEMIC ACTION AGAINST BURROWING NEMATODES INFECTING CITRUS[1]

A. C. Tarjan

Abstract

An apparatus and method for pressure injection of chemicals into trees is described and illustrated. Eighty-nine Valencia orange trees infected with burrowing nematodes were injected with 83 formulations of 54 chemicals. Results are expressed in terms of nematodes surviving at intervals up to 12 weeks. Although some of the materials tested show promise as nematocides, extent of control appears to vary with fluctuation in nematode population during the sampling period.

The effective control of spreading decline of citrus caused by the burrowing nematode Radopholus similis (Cobb) Thorne has been one of the most important research goals pursued by citrus pathologists in Florida during the past 6 years. The current practice of removing diseased trees, followed by application of soil fumigants with subsequent fallow cultivation of the land, has been criticized understandably in some cases because of economic deprivations suffered by affected grove owners. Then, too, it has been difficult to impress growers with the contagious nature of the disease and the resultant debilitation and loss of yield (8). Curative, rather than eradicatory, means of controlling the disease would be preferred, and work along therapeutic lines has not been lacking (1, 6, 7).

Early in 1956 the author undertook a program of testing materials that may show systemic activity in diseased citrus trees. Objectives of this study were not only the discovery of nematocidal chemicals, but the detection of nematode antimetabolites and chemicals that might alter the normal life processes of the pathogen to the benefit of the afflicted trees. Such chemicals usually are applied by soil treatment, foliar sprays, or introduction of chemicals into the trunks of diseased trees. Although the first method of treatment has been and still is being employed by various workers, it was rejected in this study because of the physical characteristics of most Florida citrus soils. These soils usually are extremely sandy loams with low organic matter content and introduced chemicals usually are leached from the rhizosphere. Spray application of chemicals for therapy of nematized plants has not proved feasible. The author has participated in screening tests where 200 chemicals were applied by this method to nematized plants without any valid indication of nematode control (9).

The trunk injection method of treatment was first demonstrated by Howard (3) who applied a 0.5 percent diaminoazobenzene dihydrochloride solution to maple trees with the bleeding canker disease. Tarjan and Howard (10) reported a procedure in which dry chemicals were placed in holes bored in the trunks of elms afflicted with Dutch elm disease. Ford (2) used a similar "dry pack" method in testing systemic chemicals incorporated with a carbowax carrier against citrus spreading decline. An effective method for rapidly introducing aqueous chemicals into trees was reported by Southwick (4) who successfully alleviated symptoms of iron deficiency in orange and lemon trees by pressure-injecting aqueous ferrous sulfate into holes in the trunks. This method was further investigated and found practical by Stewart and Leonard (5), who kindly instructed this author in its capabilities and application.

EQUIPMENT

Exploratory chemical injections were first conducted using an apparatus essentially similar to that described by Southwick (4). The equipment consisted of an airtight 4-gallon iron tank with a removable pressure gauge for introduction of aqueous chemicals. The tank also was equipped with a compressed air intake valve which, when the container was sealed, was charged with 125 pounds of air. A side arm situated near the pressure gauge accommodated four shut-off valves, each of which was connected to a length of 1/4-inch copper tubing. Four 5/8-inch diameter holes were drilled 5 inches into the trunk of the tree, and hollow lag screws

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inserted into the holes. After the copper tubing from the tank was securely coupled to the projecting lag screws, the shut-off valves on the side arm were released, permitting the liquid in the tank to enter the tree.

The need for a more versatile pressure injection apparatus stimulated the construction of a unit of increased capacity, with flexible plastic feed lines rather than copper tubing. Use of an 8-gallon DeVilbiss Pressure Feed Tank, Type OM 5092-1 with removable lid facilitated cleaning of the tank between chemical treatments. On the lid were a pressure gauge, an air intake with a 1/4-inch globe type valve and adjustable pressure regulator, and an outlet with a 1/4-inch globe type valve. A suitable compressed air reservoir was obtained by using a standard military low pressure oxygen cylinder, type GI, spec. N, no. 9440321 which was fitted with a 1/4-inch globe type valve at one end and a 1/4-inch DeVilbiss air stopcock at the other end. This air source was connected to the air intake of the feed tank with 5/16-inch O. D. Carlon "C" plastic tubing. Such tubing is inexpensive, flexible, and can easily withstand the 110 pounds of air pressure used in these tests. A Briggs and Stratton portable air compressor, model N, type 205279, such as used to service military aircraft, furnished compressed air. Another length of Carlon plastic tubing connected the outlet of the feed tank to a manifold mounted on a 4-compartment wooden box. This manifold consisted of a 3/4-inch brass pipe "header" capped at each end and a fitting on top to accommodate the line from the feed tank. On one side of the "header" were welded two 4 x 1/4 inch and two 2 x 1/4 inch brass nipples with a 1/4-inch globe type valve on each. Suitable lengths of Carlon tubing affixed to these side nipples terminated in fittings which were connected to injection screws immediately prior to treatment. These were 4 x 1/2 inch lag screws with a 3/16-inch diameter hollow bore lengthwise in the shank, and with a 1/2-inch nut with brazed copper fittings welded to the top. The holes in the tree trunk were excavated using a heavy duty pneumatic Aro drill, "22" series, 2400 rpm, Model 7180 equipped with a 7/16-inch diameter solid center auger bit; the drill was operated by a line from the air compressor. The Carlon plastic tubing was connected to the various components of the apparatus with Swagelok brass fittings, 5/16-inch. O. D. plastic tubing x 5/16-inch male IPT, #500-1-4. These fittings were composed of a connector, ferrule, and sleeve which were attached to the plastic tubing, while the accompanying main body of the fitting was connected to the other member of the union. A secure, pressure-tight connection was obtained by use of a wrench. The components described above are illustrated in Figure 1.

PROCEDURES

The normal procedure for applying a treatment begins with introduction of the candidate chemical solution into the pressure tank. After filling, the lid of the tank is clamped firmly into position and the compressed air cylinder is connected to the air intake valve on the tank lid. Then one of the two hose lines on the portable air compressor is connected to the second outlet on the air cyclinder containing the DeVilbiss air stopcock. The compressor is operated and all valves between it and the pressure feed tank are opened, allowing an increase to the desired air pressure of 110 pounds. After attaching the pneumatic drill equipped with auger bit to the second hose line from the air compressor and attaining air pressure of at least 80 pounds, four holes are bored into the tree trunk (Fig. 2). The holes are bored tangentially so they are as close to the sapwood as possible and in a slight downward angle; for citrus trees it has been found convenient to place these holes in the trunk about 4 to 8 inches from the ground line. After each hole is bored it is filled with water, conveniently supplied with a plastic squeeze bottle, to prevent the development of an air block in the conducting tissues of the tree (Fig. 3). After insertion of the lag screws in the holes by a wrench or similar tool (Fig. 4), the plastic lines are "bled" to make the chemical solution immediately available (Fig. 5), and the lines are then attached to the lag screws. Once the desired pressure of 110 pounds has been obtained, the air compressor is disconnected from the compressed air cylinder and the necessary components can be left by the tree being treated (Fig. 6). After the liquid in the pressure feed tank has entered the tree, the lines are disconnected from the lag screws which are retrieved from the trunk. Each of the four holes in the tree trunk is sealed by the insertion of a #3 cork and the wound covered with antiseptic tree paint. (Fig. 7).

The flexibility of the system described naturally is dependent upon the number of trees to be treated and the availability of sufficient manifold boxes, compressed air reservoirs, and pressure feed tanks of adequate capacity. Figure 8 illustrates the equipment necessary for treating four trees simultaneously. In this case, two compressed air reservoirs furnish the necessary volume of air needed to move the liquid from the pressure feed tank to the central distributing manifold. Each of four lines originating at the central manifold is connected to

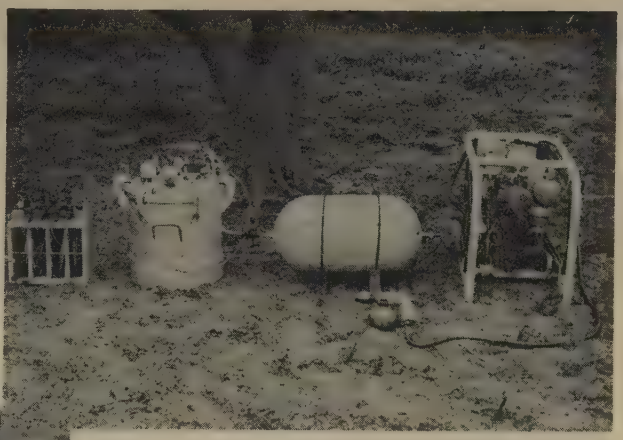

FIGURE 1. Apparatus used for pressure injecting chemical solutions into trees. From left to right: 4-compartment box with distributing manifold mounted on top, 8-gallon pressure feed tank, compressed air cylinder, and portable air compressor. The pneumatic drill equipped with auger bit is shown directly in front of compressed air cylinder.

FIGURE 2. Pneumatic drill and auger bit used for drilling holes in tree trunk.

FIGURE 3. Once hole is excavated, it is immediately filled with water applied from plastic squeeze bottle in order to prevent air block within adjacent conducting tissues of tree.

FIGURE 4. Application of hollow lag screws to holes in trunk.

FIGURE 5. "Bleeding" plastic lines prior to connection with lag screws.

FIGURE 6. Apparatus left at site of treatment during injection period of 12 to 48 hours.

FIGURE 7. Application of antiseptic tree paint to sealed wound following removal of injection apparatus.

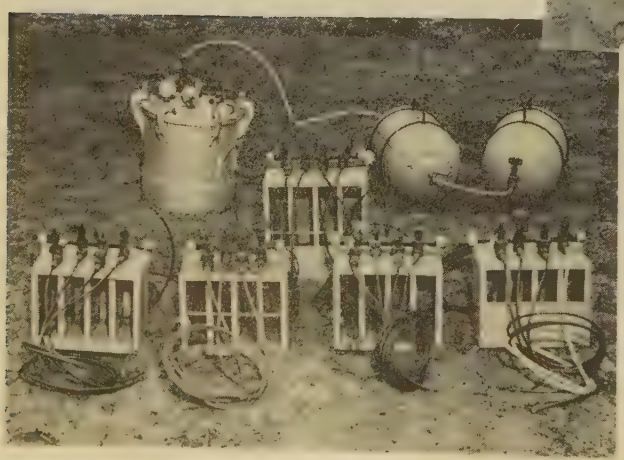

FIGURE 8. Injection equipment needed for simultaneous treatment of four trees.

an additional manifold servicing a separate tree. Additional equipment would permit simultaneous injection of more trees, if necessary. It should be pointed out, however, that in such an arrangement the amount of chemical entering any one tree can not be determined unless flow meters or similar devices are provided.

CHEMICALS USED

In the selection of various chemicals for testing, solubility in or emulsifiability with water was of paramount importance. Previous trials had shown that most chemical solutions and emulsions of very low viscosity could be injected into citrus trees. Solutions of certain dye-like chemicals, such as potassium permanganate, invariably were "rejected" by trees, as were emulsions of noticeable consistency. In one treatment of an opaque fatty acid emulsion, the tree actually exerted a pressure greater than the 110 pounds forcing in the chemical and clear sap apparently was forced into the plastic feed lines by the tree. It was concluded that the rapidity with which a chemical preparation was taken in by a tree was governed mainly by the prevailing weather, amount of foliage on the tree, soil moisture, and viscosity of the chemical preparation.

The majority of the chemicals tested were injected into Valencia orange trees on rough lemon rootstock. These trees had been planted in 1942 at Lucerne Park, Florida, where spreading decline was first detected in 1928 (8). The trees were noticeably stunted, with trunks measuring from 5 to 8 inches in diameter about 1 foot from the soil line. Feeder roots obtained from these trees almost always yielded specimens of R. similis.

The test procedure, for the most part, involved the initial application per tree of 4 gallons of 2 1/2 percent chemical solution, using 110 pounds air pressure. When compounds of known or suspected phytotoxicity were involved, the initial concentration usually was lower. Ordinarily, all of the material was taken in by the tree during the following 12 to 48 hours. About a pint sample of feeder roots from two locations around the periphery of the tree at a 2 to 3 foot depth was obtained at 1, 4, and 12 week intervals after injection. The roots were washed and weighed, then incubated for 4 days at laboratory temperatures in a pint jar, and then washed again for the recovery of nematodes evacuating the roots as proposed by Young (11). The number of evacuated burrowing nematodes was determined, and the resulting data were recomputed to reflect the number of R. similis per gram of feeder root per sample.

The above technique appears to offer a satisfactory means of evaluating chemicals using mature trees in situ. Although such a procedure may be in sharp contrast with the usual greenhouse screening techniques, the author has participated in the greenhouse testing method, with subsequent field trials of resulting promising chemicals, without tangible success. In using the one tree evaluation technique for chemicals just described, it was accepted that any chemical showing promise would subsequently be retested a number of times, with a gradual increase in the number of replicate trees used and the adoption of statistical plot design.

RESULTS

A list of the chemicals tested from 1956 to 1958 is presented in Table 1. Some of these materials show promise by virtue of the decrease in the number of nematodes in feeder roots obtained during the 12-week sampling period. However, normal nematode population fluctuations may have strongly influenced the results obtained. Nematode populations are dynamic and subject to the ravages of predators, insufficient food supply, and other unfavorable environmental conditions, the combined effects of which are often difficult, if not impossible, to evaluate. Although the information obtained using the sampling techniques previously described is thus regarded as somewhat unreliable, a more adequate means of deducing the desired information is unknown to the author. At least, any chemical eliminating root nematode populations within the sampling period could be detected by use of the described methods.

The pressure injection technique proved to be relatively dependable and easily applied. It represents an infallible method by which materials in aqueous form can be introduced directly into trees without the accompanying uncertainty involving the solubility and penetrability of chemicals applied as foliar sprays, trunk paints, or dry packs. Its use may facilitate rapid acquisition of information on downward translocation of certain chemicals. For example, it was found that barium, when applied as an acetate salt, readily moves to all parts of the tree, including the roots. It appears to the author that such methods offer considerable promise for studying the translocation of potential systemic nematocides or nematostats in trees.

Table 1. Results from pressure injection of aqueous chemicals into burrowing nematode-infected citrus trees.

Material	Percent Conc.	Gal.[a] Injected	No. *R. similis* per gm. of feeder root at indicated sampling dates			Tree[b] Performance
			1 wk.	4 wks.	12 wks.	
Allyl urea	2.5	4.0	6.0	--[d]	4.0	3
Aluminum chloride	1.0	2.0	7.0	0.3	0.8	4
Aluminum chloride[c]	2.5	4.0	16.0	--	--	0
Ammonium molybdate	2.5	4.0	--	--	--	0
Ammonium vanadate	0.5	2.5	1.0	--	--	0
Barium acetate[e]	2.5	4.0	0.8	6.4	6.8	4
Barium acetate	5.0	1.75	5.0	2.0	1.3	4
Barium acetate	5.0	3.75	--	--	--	0
Barium chloride	1.0	2.75	3.0	2.0	5.3	4
Barium chloride	1.5	3.5	82.0	17.0	2.6	4
Barium chloride	2.5	2.0	0.3	0.6	1.1	4
Barium hydroxide	2.5	4.0	0.3	1.9	9.2	4
Barium nitrate	1.25	4.0	5.4	4.0	2.1	4
Barium nitrate	3.0	4.0	258.0	12.7	2.2	4
Beryllium sulfate	2.5	3.75	4.0	--	--	0
Biopal URO[f] + phosphoric acid[g]	(100 ppm iodine)	0	--	--	--	--
Biopal URO + phosphoric acid	(200 ppm iodine)	1.25	0.3	0	4.4	4
Biopal URO + citric acid[g]	(100 ppm iodine)	3.75	0.4	0.3	6.4	4
Biopal URP + citric acid[c]	(200 ppm iodine)	2.5	1.4	0.6	1.2	4
Biopal URO + citric acid[c]	(250 ppm iodine)	4.0	2.8	2.5	0.6	4
Biopal URO + citric acid[c]	(300 ppm iodine)	4.0	1.4	20.6	0.6	4
Boric acid	1.0	3.0	--[h]	--	--	4
Boric acid	2.5	3.5	16.0	3.0	--	0
Cadmium acetate	1.25	4.0	1.3	4.2	--	0
Cadmium acetate	2.0	4.0	0.8	--	--	0
Cadmium nitrate	2.5	3.75	1.6	--	--	0
Cerous chloride	1.5	2.5	1.0	7.6	0	3
Cerous sulfate	1.0	3.75	4.0	10.1	0.5	4
Cerous sulfate	2.0	1.25	407.0	0.7	3.3	4
Chlorophenol, para[i]	0.1	1.0	--	61.0	--	4
Didymium acetate	0.5	1.0	1.0	0.2	1.8	4
Didymium acetate[c]	1.0	0	--	--	--	--
Diphenylamine[k]	0.1	2.0	--	75.0	--	4
Ferrous ammonium sulfate	2.5	4.0	1.1	--	--	0
Glycine[e]	2.5	4.0	5.5	5.0	1.3	4
Glycine	3.0	0	--	--	--	--
Glycine	5.0	4.0	12.0	3.9	--	0
Hexadecylamine acetate[k]	0.1	2.0	--	101.0	--	4
Hexadecylamine acetate[l]	0.25	2.0	--	85.0	--	4
Lanthanum ammonium nitrate	1.0	3.75	--[d]	0	1.2	4
Lithium nitrate	0.5	3.75	6.1	0.3	0	4
Lithium nitrate	1.0	3.75	--	--	--	0
Lithium nitrate	2.5	4.0	32.0	--	--	0
Merthiolate	0.1	4.0	6.2	3.6	--	0
Merthiolate	0.25	2.75	--	--	--	0

Table 1. concluded.

Merthiolate	0.5	1.0	--	--	--	0
Molybdenum trioxide	0.1	0	--	--	--	--
Naphthylamine, alpha[i]	0.1	1.0	--	62.0	--	4
Neodymium nitrate	1.0	3.0	0	0	34.4	4
Nickle sulfate	1.0	3.75	3.0	0	0.1	4
Nickle sulfate	2.5	4.0	18.0	--	--	0
Phenoxyacetic acid[i]	0.1	2.0	--	215.0	--	4
Potassium ferrocyanide	1.0	4.0	16.0	--	--	0
Potassium iodide	0.5	3.75	--	--	--	0
Potassium iodide	1.0	3.75	--	--	--	0
Potassium permanganate	2.5	0	--	--	--[h]	--
Potassium phthalate	2.5	2.75	9.0	1.0		1
Rare earth chlorides	1.0	2.0	10.6	0	0	3
Rare earth chlorides	1.5	3.75	--	--	--	0
Rare earth sulfates	1.0	1.75	0.5	0	11.0	4
Rare earth sulfates	2.5	3.75	--	--	--	0
Sodium acetate[c]	1.0	4.0	0.5	0.7	1.1	4
Sodium cobaltinitrite	0.5	4.0	1.2	0.1	0.2	4
Sodium cobaltinitrite	2.5	3.75	0.7	--	--	0
Sodium diethyl dithiocarbamate[k]	0.1	2.0	--	131.0	--	4
Sodium formate	1.25	4.0	23.0	8.0	0.9	4
Sodium phosphate monobasic[c]	2.5	3.75	3.0	1.5	1.2	2
Sodium salicylate	0.25	4.0	0.7	4.3	0	4
Sodium salicylate[c]	0.5	3.75	2.6	0.2	2.6	4
Sodium salicylate	1.25	1.75	0.3	0	--	0
Sodium salicylate[c]	2.5	2.5	16.0	19.2	--	0
Sodium sulfite	1.25	3.75	38.0	3.0	0	3
Sodium tungstate	2.5	3.75	--	--	--	0
Stannous chloride	2.5	3.75	0	6.0	2.0	4
Strontium nitrate	2.5	4.0	35.0	8.0	3.9	2
Thorium sulfate	1.0	1.0	2.2	0.2	1.8	4
Titanium potassium oxalate	1.5	1.25	7.0	6.3	0.7	4
Uranium acetate	2.5	3.0	3.0	3.7	1.0	2
Vanadium sulfate	1.0	4.0	--	--	--	0
Vanillin	1.5	2.0	0	0	5.6	4
Zinc acetate	2.5	0	--	--	--	--
Zirconium sulfate	1.0	3.25	7.5	4.1	6.1	4
Zirconium sulfate	2.5	0.5	27.0	18.3	3.0	4

[a] Number of gallons taken in by tree.

[b] Tree performance rating:
- 0 - Dead from treatment.
- 1 - Completely defoliated but new growth subsequently formed.
- 2 - Partially defoliated.
- 3 - Slightly defoliated.
- 4 - Unaffected by treatment.

[c] Average of two trials.

[d] Not sampled through error.

[e] Average of three trials.

[f] An iodine-surfactant complex.

[g] Ten percent by weight.

[h] Insufficient roots for sampling.

[i] Average of 4 replicates sampled only at 4 weeks after treatment.

[j] Average of 4 replicates sampled only at 6 weeks after treatment.

[k] Average of 4 replicates sampled only at 8 weeks after treatment.

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APPLICATION OF CASTOR POMACE AND CROPPING OF CASTOR BEANS TO SOIL TO REDUCE NEMATODE POPULATIONS

Bert Lear

Observations reported by various growers have indicated that the use of castor pomace as fertilizer also resulted in some degree of root-knot nematode control. Other reports suggest that growing castor beans, Ricinus communis, in a field results in some control of root-knot nematodes on crops following castor beans. Pomace is the pulpy mass left after the oil has been expelled from the beans. With increased acreage of this crop in California, the available quantity of pomace has increased and economic uses for it are being sought.

The author tested this material against the golden nematode of potatoes, Heterodera rostochiensis, about 10 years ago while at the Nematode Research Laboratory on Long Island, New York. As measured by the number of larvae emerging from cysts washed from soils treated with various amounts of pomace, rates equivalent to approximately 5 to 10 tons per acre were found necessary before significant reductions were obtained.

In experiments reported here, test organisms included root-knot nematodes, Meloidogyne javanica javanica, and the sugar-beet nematode, Heterodera schachtii. In the first experiment glazed crocks of 1/2-gallon capacity were filled with sandy loam soil infested with these nematodes. Separate series for each nematode species included three replicate crocks for five rates of pomace and check. Tomato seedlings and sugar-beet seeds were planted in the respective series immediately after mixing the pomace with the soil. After 30 days gall counts were made by washing the tomato roots from the soils in the root-knot nematode series. White female counts were obtained by washing the sugar beet plants and soil through a 60-mesh screen.

In the second experiment glass mason jars of 1 pint capacity were used for treatment chambers. The pomace was mixed with the soil and the jars sealed. After 7 days the soils were transferred to clay pots in the greenhouse and kept moist for an additional 7 days before tomato transplants and sugar beet seeds were planted. Root gall and white female counts were obtained as previously described.

Data (Table 1) indicate that large amounts of pomace must be mixed with soil to obtain significant reductions in nematode populations. Whatever the toxicant is, it appears to be present in very small amounts. The high rates needed may make commercial use of this material not feasible. In addition, the problem of mixing this material adequately to required depths adds to

Table 1. Survival of root-knot nematodes and sugar-beet nematodes in soil treated with various amounts of castor pomace.

Indicator plants planted immediately following application of pomace.

Pomace per 1/2 gallon (grams)	Root-knot nematode Mean number galls/plant	Sugar-beet nematode Mean number females/plant
0 (check)	217	260
0.5	201	272
1	233	219
2	210	174
4	101	80
10	87	79

Indicator plants planted 14 days after application of the pomace to soil.

Pomace per pint (grams)	Root-knot nematode Mean number galls/plant	Sugar-beet nematode Mean number females/plant
0 (check)	85	94
1	105	96
2	112	100
3	88	56
4	79	46
5	40	22

the difficulties of its use. Stunting of tops and roots was noted on those plants grown in soils treated with high rates. This may account, in part, for the reductions in nematodes present at the higher doses because of more limited root systems.

To check on the possible reduction in nematode populations in soils cropped to castor beans, the following experiment was conducted. Sandy loam soil infested with M. javanica javanica was thoroughly mixed and placed in 6-inch clay pots. Castor beans were grown in 1/2 of these pots. The remaining 1/2 were kept fallow but moist in the greenhouse. After 60 days castor bean plants were removed from two pots and the roots were washed clean and examined for presence of galls and egg masses. Typical gall formation on the roots was not found, but many egg masses were evident on the root surfaces. An average of 247 egg masses per root system was observed. Tomato plants grown in the pots cropped to castor beans averaged 122 galls per plant whereas tomatoes grown in pots which had remained fallow resulted in only 32 galls per plant. Castor bean plants removed after 90 days averaged 112 egg masses per plant. Many galls were produced on tomato plants grown in soil infested with castor bean roots containing egg masses.

Under conditions of these experiments, fallowing reduced root-knot nematode populations more effectively than cropping to castor beans. It is possible that longer growing periods would result in greater reductions. Experiments are in progress in which castor beans will be cropped to soils for as long as 6 months. Additional experiments also are in progress using M. incognita acrita as the test organism.

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A REPORT OF GRASS DISEASES OBSERVED IN WEST VIRGINIA[1]

Edward S. Elliott

This report is primarily a listing of grass diseases identified in West Virginia that have not been included in earlier lists[2, 3]. Some of the grasses have little or no forage value in this State. They are included because the organisms associated with them may be the same, or similar to those causing diseases of economically important grasses. Certain saprophytes or weak parasites are listed because they are commonly associated with specific grass hosts and may be of greater importance under conditions favorable to their parasitic development.

An estimate of disease severity is made to give some indication of their importance in this region. Each disease is classified as major (1), minor (2), rare (3), or of unknown importance (4). The distribution of each is listed as general if it appeared in a number of counties. If any question existed concerning the distribution of a disease, only the county or counties in which it was found is given.

Specimens of diseased plants reported here have been added to the Mycological Herbarium at West Virginia University. Fungi causing diseases on specific hosts which apparently have not been recorded previously from this State are indicated by the symbol # following the information on distribution.

AGROPYRON REPENS (L.) Beauv., QUACKGRASS

Rhynchosporium secalis (Oud.) J. J. Davis, Leaf Scald, (4), Monongalia Co., #.

AGROSTIS ALBA L., REDTOP

Helminthosporium erythrospilum Drechs., Leaf Spot, (1), General, #. A number of different collections of this common Helminthosporium on redtop have been examined, including the material reported in 1954 (2) to be H. stenacrum. It is evident now that these are all H. erythrospilum Drechs. Considerable variation occurs in average width of conidia in different collections, some being well within the range of H. stenacrum. A typical collection however was conidia measuring 13-16 x 42-97 μ((3 to 10 septate).

ANDROPOGON VIRGINICUS L. BROOM-SEDGE

Rhizoctonia solani Kuehn, Summer Blight, (4), Monongalia Co., #.

Sphacelotheca occidentalis (Seym.) Clint., Seed Smut, (4), Monongalia Co., #.

ANTHOXANTHUM ODORATUM L. SWEET VERNAL GRASS

Ascochyta sorghi Sacc. Leaf Spot, (4), Monongalia Co., #. Lesions small, elliptical, brown with purple borders; pycnidia scattered, golden brown with dark cells surrounding the ostiole; conidia straight or somewhat curved, 12-16.5 x 2.5-3.0 μ, with several guttulations, mainly near the septum.

Helminthosporium dematoideum Bubak & Wrob., Mold, (4), Monongalia Co., #. Conidia are 10.4-13.9 x 15.6-41.8 μ and 2 to 5 septate.

Puccinia graminis Pers. Stem Rust (1), General, #.

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

BROMUS INERMIS Leyss., SMOOTH BROME

Stagonospora bromi Sacc. Leaf Blotch (2), General, #.

BROMUS SECALINUS L. SOFT CHESS

Ascochyta sorghi Sacc., Leaf Spot, (4), General, #.

DACTYLIS GLOMERATA L. ORCHARD GRASS

Rhynchosporium orthosporum Caldwell, Scald (4) Monongalia Co., #.

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[1] Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 595.

[2] Elliott, Edward S. 1954. Notes on forage plant diseases observed in northern West Virginia during 1953. Plant Disease Reptr. 38: 279-281.

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DANTHONIA SPICATA (L.) Beauv., POVERTY OATGRASS

Helminthosporium cyclops Drechs., Leaf Spot, (4), Monongalia Co., #. Although the conidia are somewhat shorter and the hilum is not as conspicuous as that described for this species, there is little question that this material can be assigned to H. cyclops. Conidia are 13.9-18.9 x 41.8-58.2 μ(4 to 6 septate).

DIARRHENA AMERICANA Beauv. TWIN GRASS

Colletotrichum graminicola (Ces.) G. W. Wils., Anthracnose (4), Upshur Co., #.

DIGITARIA SANGUINALIS (L.) Scop. HAIRY CRABGRASS

Colletotrichum graminicola (Ces.) G. W. Wils., Anthracnose (4), Monongalia Co., #.

DIGITARIA ISCHAEMUM (Schreb.) Muhl. SMOOTH CRABGRASS

Piricularia grisea (Cke.) Sacc. Blast (2), Monongalia Co., #.

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

ELEUSINE INDICA (L.) Gaertn. GOOSE-GRASS

Helminthosporium hadrotrichoides Ell. & Ev., Leaf Spot, (1), General, #. The dark olivaceous conidia measure 15.9-19.1 x 34.8-66.1 μ (3-6 septate).

FESTUCA ELATIOR VAR. ARUNDINACEA (Schreb.) Wimm. TALL FESCUE

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

MUHLENBERGIA SCHREBERI Gmel., NIMBLEWILL

Davisiella elymina (Davis) Petrak., (4), Monongalia Co., #. Pycnidia closely associated with clypei of Phyllachora sp.; spores uniseptate, usually 2- or 4- guttulate, 8.5-10.4 x 2.8-3.5μ.

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

PANICUM LATIFOLIUM L.

Balansia strangulans (Mont.) Diehl, Black Ring, (4) Preston Co., #. This material has been confirmed by W. W. Diehl. Black ring has not previously been reported on this species of Panicum.

PANICUM CLANDESTINUM L.

Balansia strangulans (Mont.) Diehl, Black Ring, (3), Monongalia Co.

PASPALUM PUBESCENS Muhl. HAIRY PASPALUM

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

PHALARIS ARUNDINACEA L. REED CANARY GRASS

Stagonospora foliicola (Bres.) Bub., Tawny Blotch (4), Monongalia Co., #. The spores are 3.2-4 x 20.9-35 μ and 3 to 5 septate.

PHLEUM PRATENSE L. TIMOTHY

Rhizoctonia solani Kuehn, Summer Blight (4), Monongalia Co., #.

POA COMPRESSA L. CANADA BLUEGRASS

Colletotrichum graminicola (Ces.) G. W. Wils., Anthracnose, (4), Monongalia Co., #.

Erysiphe graminis D. C. Powdery Mildew (4) Hampshire Co., #.

Puccinia graminis Pers. Stem Rust, (4) Monongalia Co., #.

Puccinia poae-sudeticae (West.) Jørst., Yellow Leaf Rust (4), Preston Co., #.

POA PRATENSIS L. KENTUCKY BLUEGRASS

Darluca filum (Biv. ex Fr.) Cast. (4) General, #. Pycnidia in pustules of Puccinia poae-sudeticae (West.)Jørst.; uniseptate, strongly tapered spores which measure 10-15 x 3.5-4.2 μ.

Puccinia poae-sudeticae (West.)Jørst., Yellow Leaf Rust (2), General, #.

Rhizoctonia solani Kuehn, Summer Blight (4) Monongalia Co.

Septoria macropoda var. septulata (Gonz. Frag.) Sprague, Purple Leaf Blotch, (4), Monongalia Co., #. The needle-like spores of this variety measure 33.0-62.6 x 1.2-1.5 μ. Septations are indistinct.

SETARIA LUTESCENS (Weigel) F. T. Hubb. YELLOW BRISTLEGRASS
Rhizoctonia solani Kuehn, Summer Blight, (4), Monongalia Co., #.

SPOROBOLUS VIRGINIFLORUS (Torr.) Wood, POVERTY DROPSEED
Rhizoctonia solani Kuehn, Summer Blight, (4), Monongalia Co., #.

TRIODIA FLAVA (L.) Smyth, PURPLE TOP
Rhizoctonia solani Kuehn, Summer Blight, (4), Monongalia Co., #.

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A COMPARISON OF DIFFERENT METHODS USED IN CONDUCTING SURVEYS OF RACES OF THE CROWN RUST FUNGUS[1]

M. D. Simons and L. J. Michel[2]

Abstract

The use of single-pustule isolates of the crown rust fungus from highly susceptible varieties of oats provided estimates of the relative prevalence of race groups 202 and 216 that were probably not significantly different from the estimates provided by bulk collections from all varieties. The single-pustule isolates appeared to give a more accurate estimate of the prevalence of race groups 264 and 290 than did the bulk collections. The single-pustule isolates were also more efficient in differentiating races. Isolation and identification of single-pustule isolates showed that most collections from susceptible varieties contained mixtures of different races. The use of large numbers of bulk collections to inoculate new strains of oats believed to have value as sources of resistance provided valuable information not otherwise obtainable.

INTRODUCTION

The two principal objectives of the annual survey of pathogenic races of the fungus causing crown rust of oats (Puccinia coronata Cda. var. avenae Fraser & Led.) are to estimate the relative prevalence of the various known races and to discover new and potentially dangerous races and sub-races as soon as possible after they appear. In an earlier paper (3) some of the problems involved in conducting this survey were presented. These problems were, and still are, largely concerned with methods of sampling the fungus population in order to obtain the desired information most efficiently. The paper mentioned (3) also outlined procedures for conducting the survey more expeditiously. The present paper reports the results of a study in which these procedures were compared with methods used in the past.

Reviews of pertinent literature are available (3, 9).

MATERIALS AND METHODS

The collections of P. coronata avenae used in this study were obtained from investigators distributed throughout the oat-growing areas of the United States. Many of the collections were made from the cooperative uniform cereal rust observation nurseries; others came from breeding or experimental plots and from commercial oat fields.

Races of the fungus were identified on the basis of the reactions of pure lines of the standard set of 10 differential oat varieties (9). The original seed stocks of some of the strains tested as possible new sources of resistance were furnished by J. F. Schafer; the remainder were furnished by D. J. Ward. All seed stocks were increased at Aberdeen, Idaho, by Harland Stevens.

Methods of handling host and pathogen were similar to those described by Murphy (2) and Finkner, Atkins, and Murphy (1).

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[2] Pathologist and Agricultural Aid, respectively, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

EXPERIMENTAL RESULTS

Prevalence of Known Races

For this study the collections of the crown rust fungus identified were divided into four categories. These categories and a summary of the results obtained in 1955, 1956, and 1957 are presented in Table 1. The first category included all collections. Each collection was

Table 1. Collections, isolates, and races of P. coronata avenae received and identified during 1955-57.

Year and category	Collections received[a]	Isolates identified	Races identified
1955:	Number	Number	Number
All collections	300	391	18
URN collections	115	160	12
Bulk collections from susceptible varieties	27	41	10
Single-pustule isolates from susceptible varieties	36	305	14
1956:			
All collections	322	423	20
URN collections	122	163	15
Bulk collections from susceptible varieties	32	42	10
Single-pustule isolates from susceptible varieties	50	395	27
1957:			
All collections	520	568	23
URN collections	245	263	18
Bulk collections from susceptible varieties	28	33	7
Single-pustule isolates from susceptible varieties	40	317	22
Total:			
All collections	1142	1382	30
URN collections	482	586	23
Bulk collections from susceptible varieties	87	116	16
Single-pustule isolates from susceptible varieties	126	1017	35

[a] Non-viable collections and collections containing mixtures of races that could not be identified are not included.

individually increased in bulk and used to inoculate the differential varieties as soon as sufficient urediospores were available. The second category included collections obtained in or near cooperative uniform rust nurseries (URN). These collections were also simply increased in bulk. The data for these two categories are not the same as the data that have been published (4, 6, 8) or presented in URN reports on race identification for the corresponding years, because the latter summaries also contain a great deal of information from single-pustule isolates.

The third category included bulk increases of collections obtained from varieties believed to be susceptible to all races of the oat crown rust fungus. All these collections were from two varieties, Markton and Richland, grown in uniform rust nurseries. The fourth category in-

cluded single-pustule isolates from the collections on susceptible varieties. There are more collections in this category than in the bulk collections from susceptible varieties because some of the bulk collections contained mixtures of races that could not be identified and others were not increased in bulk because of low initial viability. An attempt was made to obtain 10 single-pustule isolates from each of these collections. An average of about eight was actually obtained.

Although examining the different categories of collections or isolates from the standpoint of their relative efficiency in differentiating races was not the primary purpose of the study it is of some interest. When the ratio of number of races identified to number of isolates studied is used as the criterion of efficiency, the isolates from bulk collections from susceptible varieties were most efficient. A closer examination of the data, however, indicates that this apparent greater efficiency can probably be explained simply as a result of the relatively small number of these bulk collection isolates, and that this method of sampling is probably no more effective than the others. Nor did significant differences appear to exist among the other categories on the basis of number of isolates studied. In terms of the ratio of numbers of races identified to numbers of collections originally received, the fourth category, single-pustule isolates from susceptible varieties, was by far the most efficient. Over the 3-year period 35 races were isolated from 126 collections by this method. Only 30 races were isolated from the 1142 bulked collections from all locations, and only 23 races from the 482 bulked collections from uniform rust nurseries.

One of the principal specific objectives of the present investigation was to study the use of single-pustule isolates from susceptible varieties to obtain an unbiased, or less biased, estimate of the relative prevalence of the more commonly known races. A comparison of prevalence data obtained in this way with corresponding data obtained by three other sampling methods is shown in Figure 1. The four race groups shown, which in each case have been given the number of the most common race of the group, include all the more common and potentially important races known in the United States. The race group designated 202 includes races 201, 202, and 203. These races all attack Bond and oat varieties derived from Bond but do not attack Victoria. Race group 216 includes races 213, 216, 258, 259, 274, and 279. These races all attack Victoria. Race group 264 includes races 263, 264, and 276, which all attack Landhafer and Trispernia. Race group 290 includes races 290, 293, 294, and 295, which all attack Landhafer, but not Trispernia.

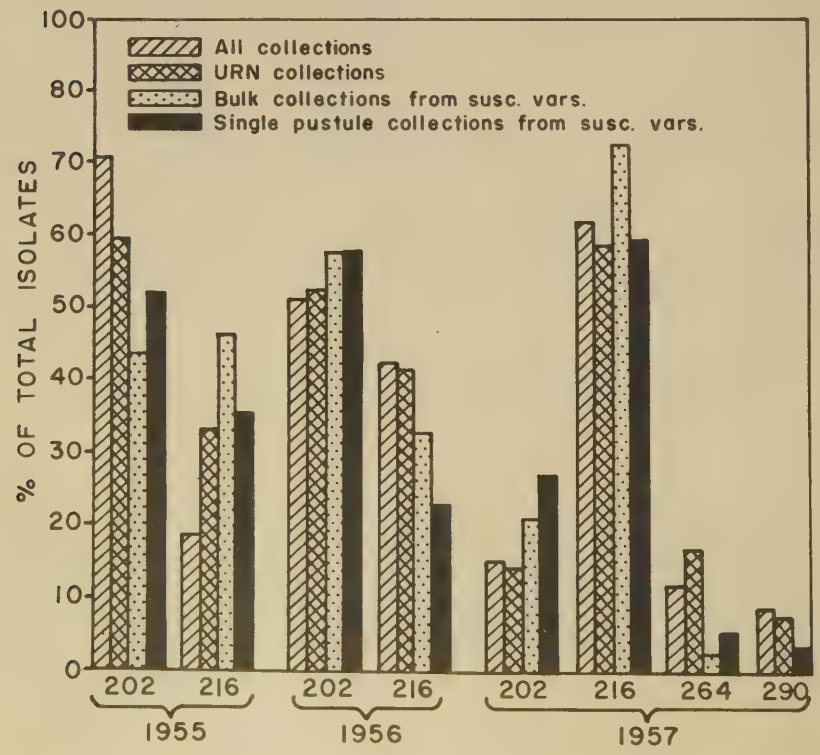

FIGURE 1. Relative prevalence of common race groups of P. coronata avenae identified during 1955, 1956 and 1957. (See text for lists of specific races included in race groups 202, 216, 264, and 290.)

In 1955 and 1956 the majority of the oats grown in the United States had either the Bond type of crown rust reaction or the Victoria type. Similarly, all the common races of the crown rust fungus fell into race groups 202 and 216. Under these conditions varieties with the Victoria type of reaction presumably would not be infected by races in race group 202, but would be infected by members of race group 216. Consequently, collections or samples of crown rust taken at random from Bond and Victoria varieties might be expected to be biased in favor of race group 216, as races of group 202 would be screened out on the Victoria varieties. On the other hand, single pustule isolates obtained from varieties susceptible to all races should be representative of the races making up the entire race population.

In 1956 isolates of race group 216 were, as expected, less common among the single pustule isolates than among collections from all varieties (Figure 1). In the same year the different sampling methods resulted in very similar estimates of the prevalence of race group 202. In 1955 the results for both race groups were the opposite of what had been expected. In view of the erratic nature of these results, it was concluded that the differences observed were due to chance, and that probably estimates of the prevalence of these two race groups by the two methods did not really differ.

In 1957 the race picture had changed markedly with the appearance of two new race groups. These groups, 264 and 290, were unique for their ability to parasitize the Landhafer and Santa Fe varieties (7). These two varieties, especially Landhafer, were being used widely as sources of crown rust resistance in oat-breeding programs and were represented in numerous experimental strains and in limited acreages of commercial oat varieties. As oats of this type were being carefully observed by many investigators, a larger number of collections than usual of crown rust on Landhafer and its derivatives were received. On the basis of isolates identified from all collections, race group 264 made up about 12 percent and race group 290 about 9 percent (Figure 1) of the crown rust race population. Numerous and widespread field observations, however, showed that these race groups were rather rare over the country as a whole and that these estimates were almost certainly too high. Race group 264 made up only about 6 percent and race group 290 about 4 percent of all the single-pustule isolates from susceptible varieties. These figures were also probably too high, and were not representative of the distribution and prevalence in oat fields.

When bulk collections from susceptible varieties were considered individually, roughly half appeared to contain mixtures of races. In most cases only two principal races seemed to be involved. However, single-pustule isolates from these same collections showed that only a very small percentage contained as little as one race, and that many contained four or five races. Eight distinct races were isolated from a collection identified in bulk in 1956 as race 216. Curiously, race 216 was not one of the eight. Eight races were also isolated from one of the 1957 collections.

Reactions of Varieties Representing Sources of Resistance

A second major objective of the annual crown rust survey is the detection of new and dangerous races as soon as possible. Such races may parasitize the more resistant of the standard differential varieties or they may attack other strains of varieties valuable as sources of resistance. In addition to being used to inoculate all of the standard differential varieties, the bulk crown rust collections received in 1955, 1956, and 1957 were used to inoculate certain other strains of oats believed to have value as sources of resistance. The most interesting of these strains are shown in Table 2. Single-pustule isolates and collections from Rhamnus spp. were also used to inoculate these strains, but the data from the bulk collections suffice to illustrate the principal points of interest. The total numbers of isolates tested on the different strains vary considerably because of availability of seed and mixtures of isolates within collections.

This information on specific strains of oats is useful in determining whether they should be utilized as sources of resistance in breeding new varieties. In 1955 several strains that preliminary testing had shown to be resistant to at least some cultures of the important prevalent races of the crown rust fungus were tested. P. I. 189625 was resistant to only 14 isolates and was susceptible to 162. As none of the 14 isolates to which it was resistant represented unusual or particularly dangerous races, this strain obviously had little value. Both P. I. 184019 and P. I. 199840 were susceptible to a fairly high percentage of the total isolates and did not show any special promise as sources of resistance.

One of the two selections from P. I. 183106 tested was resistant to all isolates, while the other was susceptible to about 1/4 of them. Determining that the two differed and that one

Table 2. Evaluation of pathogenicity of isolates of P. coronata avenae, 1955-57.

Year and Strain	Total isolates tested	Isolates		
		Pathogenic	Intermediate	Non-pathogenic
1955:				
P.I. 189625	182	162	6	14
P.I. 184019	186	41	89	56
P.I. 199840	212	109	40	63
P.I. 183106-1	209	61	0	148
P.I. 183106-20	177	0	0	177
C.I. 7233	71	0	0	71
P.I. 174513	184	0	0	184
P.I. 186609	188	0	21	167
Ascencao	188	0	21	167
1956:				
C.I. 3815	333	0	0	333
Glabrota	333	8	0	325
C.I. 7233	333	0	0	333
P.I. 174513	230	0	0	230
Ascencao	333	0	47	286
1957:				
C.I. 3815	422	0	0	422
Glabrota	425	7	0	418
C.I. 7233	422	0	0	422
P.I. 174513	443	54	75	314
Ascencao	422	0	88	334

was much superior to the other was very helpful in planning future work with them.

Two other varieties, P.I. 186609 and Ascencao, were both highly resistant to the same 167 isolates and moderately resistant or intermediate to 21 others. Apparently the two are identical and need not be maintained as separate lines.

Ascencao and P.I. 174513 illustrated the clarification of complex variety isolate relationships. Both of these varieties of oats are known to carry two genes for resistance to the crown rust fungus (5, and author's own unpublished data). In each variety one of the genes is similar to the Victoria gene and the other conditions a higher type of resistance to most races and is epistatic to the Victoria-like gene. It is also known that the Victoria-like genes condition an intermediate reaction to race 264 and that the other genes condition only susceptibility to this race.

In 1955 and 1956 race 264 did not appear in the tests under consideration, but Ascencao showed an intermediate, Victoria-like reaction to certain isolates representing several common races. P.I. 174513 was resistant to all isolates both years. Consequently the two non-Victoria-like genes were shown to be different and the non-Victoria-like gene carried by Ascencao was shown to condition susceptibility to certain biotypes of common races as well as to race 264. In 1957 the appearance of race group 264 showed both P.I. 174513 and Ascencao are more resistant to race 264 than Victoria. In the same year Ascencao proved to be highly resistant to all isolates of the new race group 290. On the other hand, P.I. 174513 was moderately or highly susceptible to all isolates of this race group. The differential variety Victoria ranged from highly resistant to moderately resistant to this race group. Thus the gap between Ascencao and P.I. 174513 widened, and in addition it was shown the the Victoria-like gene carried by P.I. 174513 differed sharply from the gene carried by Victoria.

Ascencao and P.I. 174513 also provided unexpected help in that part of the crown rust survey dealing with the relative prevalence of the various races. Under some conditions certain isolates of race group 290 tend to approach those of race group 264 in pathogenicity on the standard differentials, making it difficult to determine their true identity. However, isolates

of these two race groups were always clearly distinct on Ascencao and P. I. 174513.

Glabrota furnished another illustration of important information that can be gained by testing putative new sources of resistance with large numbers of isolates. This diploid variety was susceptible to only a few isolates and was highly resistant to all the others. Unfortunately, some of those to which it was susceptible were members of race group 290. Consequently, an oat possessing combined Glabrota and Landhafer resistance would not be resistant to all known biotypes of the crown rust fungus. The diploid variety Saia, one of the standard differentials, was also susceptible to a few isolates. None of these attacked Landhafer, however, and a combination of Saia and Landhafer should be resistant to all known biotypes.

The diploid strain C.I. 3815 and the tetraploid strain C.I. 7233 were resistant to all isolates tested. The assumption that they are probably resistant to all known biotypes of the crown rust fungus can be made with a great deal more confidence than if they had been tested only for reaction to a few cultures representing several races, regardless of how carefully the races had been selected.

DISCUSSION

When this study was started it was believed that the different sampling methods used would result in widely different estimates of the relative prevalence of the common races of the crown rust fungus. In general, however, the similarities of results obtained by the different methods were more striking than the differences. The study also showed that collections of the crown rust fungus from the field usually contained mixtures of different races. These similarities are even more difficult to explain, in view of the difficulties of interpreting reactions of mixed races of the differential varieties, as compared with interpreting results from a number of single-pustule isolates from the same collection. The answer may lie in the fact that a relatively large sample of bulk collections was used. The discrepancies that might appear in a single collection could be averaged out over all the collections to give estimates not greatly different from the estimates furnished by the single-pustule isolates.

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LOW INCIDENCE OF STORAGE MOLDS IN FRESHLY HARVESTED SEED OF SOFT RED WINTER WHEAT

John Tuite[1]

Storage molds, comprising certain species of Aspergillus and Penicillium, are of considerable importance in the deterioration of stored grain (1). Knowledge of the numbers and kinds of molds has been a useful aid in ascertaining the condition of grain. Also their prevalence can be used to evaluate various storage facilities and methods employed to maintain grain quality. Growth of these molds in seed prior to storage would obviously confound conclusions drawn from storage tests. However, previous studies indicate that there is little invasion of seeds of barley (4), oats (2), hard red spring wheat and durum wheat (5) by storage molds prior to storage. It seemed advisable to extend these studies to soft red winter wheat because of the economic importance of this wheat and because it is typically grown in a humid area.

The 732 samples examined in this study were obtained from Robert Sprunger who collected wheats for the primary purpose of comparing the accuracy of pricing and grading wheat at local elevators in Indiana (3). In 1956 Sprunger collected approximately 30 freshly harvested samples from trucks unloading at 25 different elevators located in seven counties in Indiana. The samples ranged in moisture from about 10 to 18 percent, wet weight basis, as determined by the Weston moisture meter (formerly called Tag-Heppenstall). Over two-thirds of the samples were below 14 percent moisture. Samples from the northern part of the State were higher in moisture because of the intermittent rains that occurred at harvest time. Samples were returned to the laboratory usually within a day after collection and stored at room temperature in coin envelopes until tested for storage molds. To determine internal fungi, 100 seed of each sample was submerged in 1 percent sodium hypochlorite for 1 minute, rinsed in sterile water and plated on malt agar containing 10 percent sodium chloride.

Only three of the 732 samples tested had as much as 3 to 5 percent of the seed infected by storage molds, mostly species of Penicillium and of the Aspergillus glaucus, A. candidus, A. flavus, and A. ochraceus groups. Fifteen samples had 2 percent or less of their seed infected with storage molds Since only 25 seeds of the 73,200 seed examined yielded internally borne storage molds, it appears that soft red winter wheat, like the other small grains previously tested, is not invaded by storage fungi to any degree prior to storage. It is likely that this conclusion would hold for other years in Indiana because of the diversity of the weather that occurred during the harvest period of 1956 and, particularly, when a number of fields remained unharvested for several weeks because of heavy rains.

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[1] Appreciation is expressed to Miss Theresa DeVries for technical assistance.

CEREAL YELLOW DWARF AS AN ECONOMIC FACTOR IN SMALL GRAIN PRODUCTION IN WASHINGTON, 1955-1958[1]

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Abstract

Yellow dwarf has been found in all sections of Washington. It was severe and widespread in 3 of 4 years in the limited spring cereal acreages west of the Cascade Mountains, causing an estimated $1,000,000 or more annual loss. The year of no yellow dwarf (1956) followed a sharp November freeze. East of the Cascade Mountains the climate is less favorable to grass aphids and consequently yellow dwarf was of little significance until 1958. The winter of 1957-1958 was very mild, and the spring of 1958 cool and wet. These conditions favored overwintering of aphids and led to frequent late planting of spring cereals. Losses from yellow dwarf in late-sown spring oats and barley in 1958 were heavy. Epidemics of yellow dwarf in Washington indicate that winter is a critical season for the aphid vectors.

Attempts to estimate disease losses in cereals where the crop occupies extensive acreages scattered over wide areas usually results in rough approximations of actual losses. Nevertheless the effort is worthwhile, particularly when the disease is relatively "new" to an area, as is yellow dwarf of cereals in Washington. This disease has been under study since its discovery in the State in the fall of 1954. This is a report of field observations of 1955-1958.

Virus-recovery trials and observations have established the general distribution of yellow-dwarf virus in the State. It was found one or more times in every county visited.

The geographic diversity of Washington and the weather of the past four seasons provide an opportunity to estimate the importance of yellow dwarf in the spring cereals of the State. The epidemiology of the disease is best presented in two parts, western and eastern Washington.

WESTERN WASHINGTON

The State of Washington is roughly bisected into eastern and western parts by the north to south barrier of the Cascade range. The prevailing westerly direction of air movement makes the oceanic influence quite strong in western Washington, less effective east of the Cascades.

The region west of the Cascade Mountains is devoted largely to forestry and industry, with interspersed intensively-farmed valleys and scattered farms, including important dairy and poultry enterprises. Fields of oats, barley and wheat are scattered throughout the area. Compared with cereal production east of the Cascades this cereal industry is of slight consequence, but from 3 to 4 million dollars are involved annually, mostly in spring oats. However, even with this relatively small cereal base, yellow dwarf is a major disease, as it is almost universally prevalent and often severe in this region, especially on spring grains.

The Pacific Ocean strongly influences the climate of western Washington, making it rather favorable to aphid populations among grasses. It moderates the dryness of summer and mellows the coldness of winter. Numerous meadow, pasture, lawn and weed grasses are grown. The diversified, urbanized nature of the area results in growth of many Rosaceous plants, a factor that may be of significance to the apple grain aphid (Rhopalosiphum fitchii Sand.), and other grass aphids. Regardless of the contributing factors, several species of grass aphids can usually be found in this area.

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[1]Scientific paper No. 1817, Washington Experiment Stations, Pullman. Work conducted under Project No. 1280, in cooperation with the Agricultural Research Service, Farm Crops Division.

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Yellow dwarf was prevalent and severe in 1955, 1957 and 1958, and practically non-existent in spring cereals in 1956. A severe freeze[3] in the fall of 1955 with no preceding period of hardening weather must have killed the aphids prior to preparation for winter. Even late the following spring it was almost impossible to find aphids, and the spring cereals were free of yellow dwarf. Yields of 1956 constitute the best available "check," or yellow dwarf-free crop. They are the basis for comparison in Table 1.

Table 1. Spring grain yields in bushels per acre, average of all varieties in the nursery, at three Western Washington Experiment Stations, 1955-1958. The data of 1956 are used for the standard of comparison as there was little or no yellow dwarf that year.

Cereal	1955	1956	1957	1958
		Mt. Vernon		
Oats	83	174	124	101
Barley	--	101	80	73
Wheat	40	77	44	50
		Puyallup		
Oats	60	133	65	16
Barley	70	99	--	35
Wheat	49	46	--	12
		Vancouver		
Oats	27	74	52	35
Barley	26	69	49	25, 33[a]
Wheat	15	49	18	20

[a]The 25 bushel average is for the 6-row barley nursery, the 33 bushel figure for the 2-row nursery.

The data of Table 1 are taken from plots at three western Washington Experiment Stations located, north to south, at Mt. Vernon, Puyallup, and Vancouver, and are mean yields of the 10 to 20 varieties in each nursery. The varietal composition of the trials fluctuated somewhat from year to year, but this is not considered serious. Means of all entries should serve to stabilize the data and add to their usefulness. The soils at these stations are fertile, adequately drained, and representative of the better soils of their respective regions. The cereals were seeded at the proper time in well prepared seedbeds, fertilized, weeded and meticulously harvested[4]. There were marked fluctuations in yield in spite of good agronomic practices (Table 1).

Yields at Puyallup, 1958, are particularly interesting: oats 16 bushels per acre; barley 35 bushels per acre; wheat 12 bushels per acre. 1956 yields at this station indicate the fertility of the site: oats 133 bushels; barley 99 bushels; wheat 46 bushels. The Puyallup site is fertile alluvial land. Winter wheat adjacent to the 1958 nursery was 50 to 60 inches high. The oats were uniformly diseased, about 14 inches tall, and not a plant had a tiller. This was the most severe yellow dwarf of oats seen.

Some danger exists in interpreting yield data on the basis of a single environmental factor, yellow dwarf in this case. Western Washington did not suffer catastrophic droughts or hail or insect depredations or epidemics of other diseases to account for the variations in yield. The only factor known that might bias the data seriously was leaf rust on the spring wheat at Puyallup in 1956. The major environmental factor influencing yields in the period of observation is believed to be yellow dwarf.

For decades the oats of this region have been noted for their red leaves. In Washington records as far back as 1918 a red leaf disease of oats was prevalent in western Washington and subnormal temperature during early periods of growth was listed as the cause. It is known (1) that environmental distress will cause this pigmentation in oats, as well as the leather leaf

[3]In a 48-hour period temperatures dropped from 60° F to 80°, that is, they fell from about 60° to 0° to 20° F all over the State.

[4]These nurseries are the regular varietal test plots of the Department of Agronomy, Washington Agricultural Experiment Stations, H. Austenson in charge.

fungus disease (2), but observations subsequent to knowledge of yellow dwarf disease leave little doubt that the major cause of red leaf in oats is a virus infection.

Symptoms on spring wheat usually are inconspicuous and lead to improper evaluation of yellow dwarf as a disease of that host. The actual yields reported in Table 1 show that wheat was seriously damaged.

Taking the highest figure in the 4-year series as 100, the relative grain yields for the period 1955 to 1958 were 53, 99, 62 and 45. Yields on the experimental farms, higher at Mt. Vernon than at the more southerly points, were reduced to about half by the disease. If resistant varieties could be developed the 3 to 4 million dollar present grain production could easily be increased by over a million dollars. This would be a material aid to the dairy, poultry and small, part-time farmers of the region.

There is a tendency for yellow dwarf to be more severe on the experimental farms than in farmers' fields. This may result from the contiguous concentration of the varied grasses in alleys and in forage experiments and to their repeated disturbance by various clipping and cutting experiments. These operations could easily lead to increased aphid-movement.

In spite of the limitations of the above observations, it is believed that yellow dwarf is a major factor in small grain culture west of the Cascades; its significance in this area alone ranks it as a major cereal disease of the State.

EASTERN WASHINGTON

Because of the Cascade mountain barrier, eastern Washington has a climate relatively continental in nature; the winters are colder and the summers more parched than west of the Cascades. The major grain acreages of the State are in the eastern section.

Yellow dwarf was of slight importance in most of the eastern section in 1955, 1956 and 1957. It occurred in volunteer cereals along roadsides, as scattered infected plants in fields, or as general infections restricted mostly to fields of late-sown oats along the eastern edge of the State. In these three seasons it was a minor disease in the major cereal region.

In 1958 serious losses occurred in late-sown fields of spring barley and oats in southern Spokane County, the eastern half of Whitman County, in the northern halves of Garfield and Columbia Counties, and in scattered fields in Walla Walla County. Fields of oats were so badly diseased that they appeared from the road to be "rusted." Crops grown in low areas were hit hardest as the soil in such areas remained wet longer in the spring, necessitating late seeding. Spring barley was sown over a wide range of seeding dates, some fields 3 weeks later than others. In some late-sown fields the damage from yellow dwarf was so severe that the plants would not head out. In these fields the barley plants resembled winter barley sown in the spring. The plants tillered profusely, were yellow-green in color, and only an occasional plant produced a partially emerged spike. In such fields the crop exhibited a generally grassy appearance that was recognizable from a distance, in sharp contrast to normally maturing fields in which the barley headed uniformly. Hundreds of acres of devastated barley were plowed under when the farmers involved became convinced they were a total loss. One farmer 3 miles north of Pullman, Washington plowed up 450 acres and estimated his own loss in barley and oats at $20,000. No figures are available for eastern Washington as a whole. It was obvious, however, that yellow dwarf can assume major proportions in eastern Washington under favorable conditions.

What constituted the favorable conditions responsible for this epidemic? The winter of 1957-1958 was one of the mildest on record. Temperatures at no time during the winter went much below freezing. Volunteer spring barley survived in the field. The spring was one of the wettest on record, causing considerable delays in some seedings. Winged English grain aphids (Macrosiphum granarium Kirby) were numerous in the first half of May at Pullman, the earliest they have been noted here by the senior author. The mild winter evidently permitted overwintering of aphids in record amounts; they got off to an early start, and some of the grain was seeded late, hence exposed to infection in the most susceptible seedling stages.

The corn aphid (Rhopalosiphum maidis Fitch) was unusually abundant in the stunted barley. This bluish aphid congregated in masses in the whorls and behind leaf sheaths. It was so abundant that walking a few feet through the fields left a scum of honey-dew exudate on shoes. The exact contribution of this aphid to the losses is not known. It did not colonize oats and the oats were severely yellow-dwarfed. It is thought that the early flights of English grain aphids transmitted most of the virus. The yellow dwarf-infected barley then remained vegetative, lengthening the period of the favored whorl so that the corn aphid enjoyed a susceptible host far longer than normally would be possible.

No fields of spring wheat in eastern Washington were observed in serious condition because of yellow dwarf. The reason for this is not clear. Farmers in general favor wheat in their farming operations as it is a better cash crop and they probably seeded spring wheat first and then seeded barley or oats. The seeding date alone could account for the escape of wheat. On numerous occasions severely diseased barley was found side by side with practically undamaged barley of the same variety. The only apparent difference was planting date. The strains of virus prevalent in eastern Washington in 1958 may have been avirulent on wheat. Stem rust was severe in many fields of late-sown spring wheat and this further confused efforts to interpret the events of this season.

Winter wheat and winter barley in the area apparently were undamaged. Aphid flights must have occurred late enough in the spring so that the more advanced winter cereals were beyond the very susceptible stages of development and little damaged by the disease.

CONCLUSIONS

The vicissitudes of weather the past four seasons, along with the climatic difference between eastern and western Washington, have presented an opportunity to evaluate yellow dwarf in the State. It is common and prevalent, a major disease, west of the Cascades where the winters are usually moderate. Yellow dwarf is rarely important east of the Cascades where the climate is more continental and the winters a little more severe. In the fall of 1955, a sudden drop in temperature covered the entire State. Aphids, even on the west coast, were not prepared and were essentially eliminated. The spring cereals of 1956 were free of yellow dwarf and in that year the real productive potential of the west was revealed. Following the unusually mild winter of 1957-1958, yellow dwarf became serious in late spring barley and oats of eastern Washington. It appears that epidemiology of yellow dwarf in Washington is strongly influenced by the winter season.

Resistant varieties of spring cereals are a necessity for coastal areas and they would constitute insurance against repetitions of 1958 losses in eastern Washington.

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HEAT AND DROUGHT DAMAGE TO CEREALS[1]

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Abstract

Two new physiological troubles on cereals are described: 1) heat canker on 6- to 7-inch oat plants caused by high surface-soil temperatures and 2) drought lodging in oats caused by dry top soil and soil drifting, resulting in the failure of crown-root development.

The abnormal, prolonged drought of the first two-thirds of the 1958 growing season on the Canadian Prairies produced some unusual physiological troubles on cereals which should be recorded. Although such damage was serious in isolated areas, the effect on the over-all yields was slight.

Moisture conditions were generally fairly good around May 1, and satisfactory stands resulted in early-sown fields; later seedings were thin and irregular because of the drought. The rainfall at Saskatoon in central Saskatchewan for the first two-thirds of the growing season, May 1 to July 11, was 1.34 inches, compared with a longtime average of 4.88 inches for the same period. This condition was, however, typical of the whole area concerned. On July 12 and 13 the first general rains, of 2.45 inches, fell. The temperature was above average for May, below for June, and normal for July. Sunshine was above normal for May and June and normal for July.

Heat damage on cereals during the seedling stage normally shows up as a chlorotic leaf banding (2), and on flax as a seedling blight caused by excessively high surface-soil temperatures through insolation. Fortunately, in spite of the dry conditions in 1958, the absence of unseasonably high temperatures at the end of May when the seedlings were emerging prevented serious widespread damage of the kind described above. On June 26 and 27, however, afternoon temperatures of 87° and 95° F, bright sunshine, and moderate wind velocities were recorded. Subsequently, reports of heat damage to oats were received from central and southern areas. This was a late type of heat canker damage also commonly found on flax (1), but not previously recorded on cereals on the Canadian prairies. Subsequent enquiry revealed that barley and wheat were also affected, though to a lesser degree.

Figure 1 shows oat plants with the characteristic constrictions at ground level caused by the high surface-soil temperatures. With air temperatures of 87° and 95° F on clear days, surface-soil temperatures will reach up to 130° (1, 2), sufficiently high to kill the tissues of young plants. Partially-affected plants that survived tended to lodge. This trouble was worst on late-sown fields where seedling emergence was thin and irregular. It was particularly severe on late-sown, sandy-loam fields in west-central Saskatchewan, where 75 to 80 percent damage resulted; comparable figures in some early-sown fields were 5 to 10 percent. Barley and rye were also damaged in this area, though not as severely as oats. In some instances oat fields were cut for fodder. Early seeding is the logical preventive measure for this trouble. Soil packing to encourage more even germination, and soil shading provided by surface trash, should also be beneficial.

Figure 2 shows a second type of damage to oats, characterized by severe lodging with occasional breaking off at the base. It has not previously been observed. The lodged plants usually dried up after 2 or 3 weeks. The first report of this damage came to our attention a few days before the high temperatures of June 26 and 27, but samples were received for several weeks thereafter. The crown roots were short and brittle, with several broken off. The top soil was quite dry and some of it had been removed by wind erosion after the seedlings had emerged. The soil surface then became quite hard. It appears that the prolonged dry weather and wind erosion prevented the crown roots from making contact with the sub-soil moisture.

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FIGURE 1. Heat canker on oats. The collapsed tissues shown at C were caused by high surface soil temperatures.

FIGURE 2. Oat plants which drought lodged. Dry top soil and slight wind erosion inhibited the development of the crown roots so that they failed to function as prop roots. Water was absorbed through the primary roots only.

Therefore, they died and became brittle, thereby failing to function in absorption and particularly as prop roots. Consequently, during high winds the plants tended to lean over and sometimes break off. All absorption was through the primary or seed roots. Differences in depth of seeding did not appear to affect the trouble. In some fields in southern Saskatchewan damage to oat plants ranged as high as 30 to 40 percent. In this trouble, too, earlier-sown fields were commonly less affected, but one exception was reported. At one location varietal differences were apparent. These may have been due to disease escape rather than to actual differences in resistance. The trouble was worse on oats than on barley; wheat, however, appeared to be resistant. Soil texture differences and phosphate fertilizer amendments did not appear to affect this condition. Soil erosion preventive practices should lessen this trouble.

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THE INTERRELATIONSHIP OF NITROGEN AND OTHER FACTORS AFFECTING THE BLAST DISEASE OF RICE CAUSED BY PIRICULARIA ORYZAE CAV.

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Summary

Nitrogen (as urea) applied at rates of 30, 60, 120 and 240 pounds per acre to Century Patna 231 rice produced marked differences in the intensity of rice blast caused by race 1 of Piricularia oryzae Cav. in the first half of the season. Four successive field plantings in 1956 at approximately monthly intervals extended over most of the growing season. The first planted field was inoculated and all subsequent blast development was from inoculum originating in this planting. In addition to the nitrogen factor, the age of the plants, meteorological conditions, and the quantity of inoculum present influenced leaf blast intensity by fields. Soil nitrogen in these experiments was of minor importance when meteorological factors were favorable for infection and disease development.

Experimental evidence on the influence of nitrogen on susceptibility of rice to the blast disease caused by Piricularia oryzae Cav. has been presented by a number of investigators (1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14). Most of the investigations were conducted on container-grown plants under controlled greenhouse conditions and the conclusions of the authors in general were that with increase in the amount of nitrogen a corresponding increase was found in rice blast development.

Tahara (11) appears to be the first to report a complex picture of the nitrogen-blast relationship when he states "the plant readily succumbs to the attack of the disease when the nitrogen in the plant body loses its equilibrium due to the deposition of (the total) nitrogen in an excessive amount..." His experiments were largely confined to the greenhouse, although he made limited observations of the relationship of blast to soil fertility under field conditions.

Experiments were devised to determine the inter-relationship between the rice blast fungus and rice plants growing in soils at various nitrogen levels. Successive seedings of about 4 acres each were made to observe the effect of age of plant on susceptibility also.

MATERIALS AND METHODS

Field studies were made on Pompano and Charlotte fine sand at the Indian River Field Laboratory, Fort Pierce, Florida. The sandy soil permitted manipulation of nitrogen levels. Four successive plantings of Century Patna 231 rice were made at 70 pounds of seed per acre, on May 7, May 28, July 6, and August 11, and are designated as fields 1, 2, 3, and 4 respectively.

Nitrogen rates of 30, 60, 120 and 240 pounds per acre were used, with urea (45 percent nitrogen) as the nitrogen carrier. One-half of the nitrogen was applied at planting, and the remainder was top-dressed approximately 6 weeks later, with the exception of field 4 which was uniformly fertilized at the rate of 120 pounds per acre when seeded.

Fields were approximately 400 feet square. Each of the four nitrogen treatments in fields 1 and 2 was confined to 1/4 of its respective area in a 200-foot square. In field 3 there were 16 treatments with the four nitrogen treatments randomized (four replications), each in a 100-foot square area.

Measurements of the progress of the disease were made at weekly intervals at staked sampling stations by polar-coordinates in fields 1 and 3 and by a rectangular sampling order in fields 2 and 4. The sampling stations were altered to meet the requirements of each field.

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In field 1, eight polar-coordinates were used with lines radiating outward from the center of the field at 45° intervals. Sampling stations were located along these coordinates at 12-foot intervals. In this way, field 1 was sampled at 120 stations. Twelve polar-coordinate lines at 30° intervals, totaling 180 stations, were used in field 3.

The rectangular sampling arrangement in fields 2 and 4 consisted of rows of sampling stations situated 66 feet apart and running the width of the fields. Sampling stations were placed along these rows at 15-foot intervals. In this way fields 2 and 4 were sampled at 120 stations.

The average number of lesions per foot of row of rice was used to measure leaf blast intensity. Head blast was measured as percent of heads with neck rot. Inoculations were made in field 1 in each of the four nitrogen rate plots on an area of approximately 1/2000 acre. The rice was 42 days old on June 18 when inoculated with spores of P. oryzae. The inoculated area was enclosed under a muslin tent at the time of inoculation. Spores were blown into the tent with a Jackson and Perkins midget duster. To insure coverage, the spores were mixed with a predetermined amount of perlite (a volcanic-glass diluent).

No additional artificial inoculations were necessary as blast developed in fields 2, 3 and 4 from spores originating in field 1.

Blast increase in individual fields was recorded at weekly intervals with leaf blast readings taken, whenever feasible, from the inception of infection until three successive readings resulted in no significant increase in the number of lesions. Head blast readings were started as the plants began to head and were continued until no further increase was observed.

Leaf blast readings were related to nitrogen levels as well as to interactions between the nitrogen levels and age of rice, meteorological conditions, and quantity of natural inoculum present. Therefore, each field will be discussed separately in order of planting date.

Before adequate interpretation of the data can be made, a few reported observations about blast susceptibility, age of plants, and weather conditions during the experiments should be presented. According to Andersen, Henry, and Tullis (3), the rice plant is very susceptible to leaf blast from 1 to 7 weeks of age, slightly susceptible from 7 to 11 weeks and in general resistant from 11 to 13 weeks and is again susceptible at heading time. Hashioka (5) found that the optimum age for susceptibility was 4 weeks, but stated, in contrast to the work of Andersen et al., that 1- to 2-week-old plants were only slightly susceptible.

After the initial inoculation in field 1, a gradual build-up of inoculum occurred as the season progressed, and the weather conditions became more favorable to blast development. The average duration of the period of 100 percent relative humidity was 12, 15, 18 and 17 hours for June, July, August and September, respectively. Average nightly temperatures from 1800 to 0600 hours were 73°, 74°, 73° and 74° for the pertinent parts of June, July, August and September, respectively. Thus, at the same age of development, because of the successive planting dates, the rice of fields 3 and 4 was exposed to more favorable conditions for blast development because of longer dew periods and to more inoculum than was the rice of fields 1 and 2.

RESULTS

Leaf Blast

Results are presented in Figure 1 for leaf blast development. In field 1 leaf blast was present at all nitrogen levels, but only at the 240 pound per acre treatment was there a high percentage of infection. Since at the time of inoculation the rice was 6 weeks old, subsequent infection occurred during the 7- to 13-week period when the rice was in the slightly susceptible-to resistant stage. In addition, dew conditions during this period were less favorable for blast development than they were in the later seedings. The relatively slight increase in the amount of infection may be interpreted as resulting from the gradual build-up of inoculum. Since only the highest nitrogen treatment resulted in good leaf blast infection, it is postulated that the effect of the nitrogen was such as to prolong the period of susceptibility by inducing new growth, thus permitting secondary spread.

The positive relationship between nitrogen and leaf blast intensity in field 2 provides further evidence that nitrogen is an important factor with respect to blast development in rice. All infection in field 2 occurred when the rice was 4 weeks old and in an extremely susceptible stage. The failure of the disease to increase with time in field 2 was probably due to the combination of conditions in which the greater dosage of inoculum and continuation of conditions favorable for blast development was balanced by a slight decrease in susceptibility with age of plants.

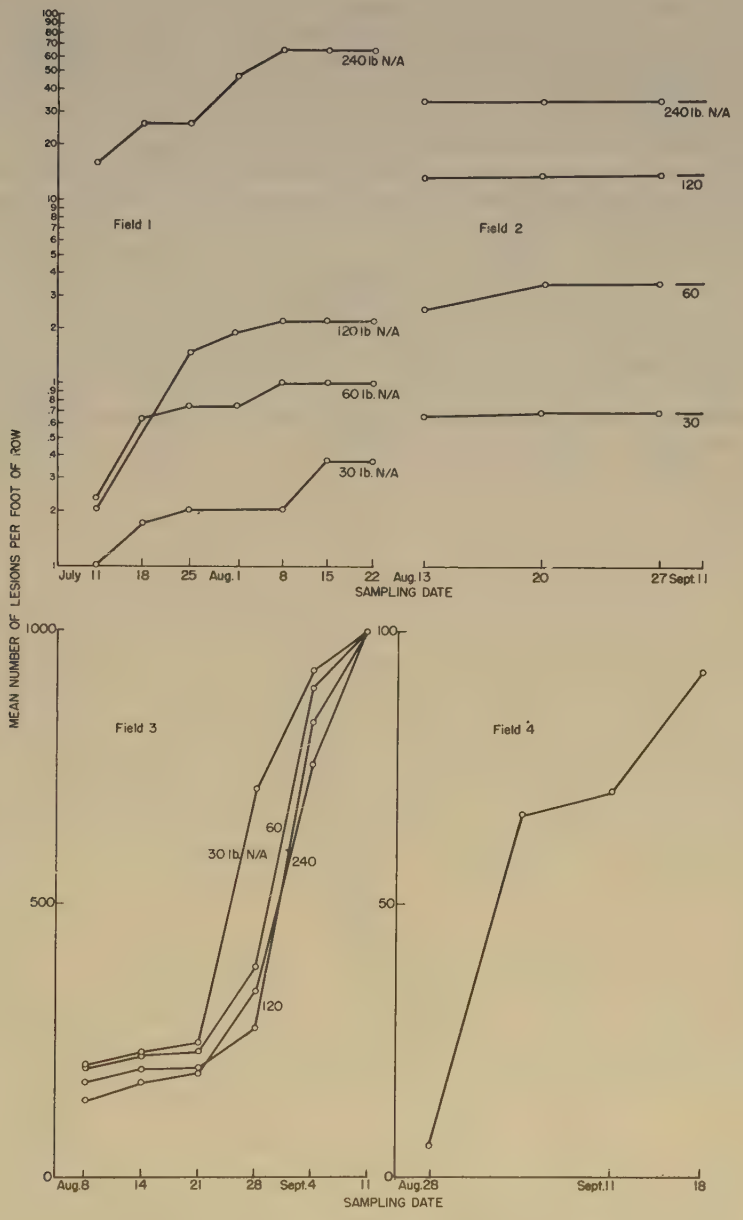

FIGURE 1. Leaf blast development in relation to nitrogen fertilization.

In field 2 the initial readings were made on July 16, at which time 75 foci of infection were found. Because of operational difficulties a complete set of readings was not made until August 13, after which time there was no appreciable increase in blast as indicated by readings taken at heading.

Leaf blast development reached the peak of severity in field 3. All rice in this field was killed within 70 days from planting. No significant differences in leaf blast intensity could be attributed to the four nitrogen treatments. Also, it should be pointed out that only 1/2 of the total amount of nitrogen was applied, or 15, 30, 60, and 120 pounds of nitrogen per acre, since, at the time the second application was due, disease intensity was so great that additional fertilizer was not applied.

Thus, it appears that even the lowest nitrogen rate was sufficient to keep the rice plants in a highly susceptible condition and allow for an enormous increase in disease intensity. Weather conditions were more ideal for blast at the time that field 3 became inoculated, and at this

time the amount of inoculum present was greater than at the time that blast developed in fields 1 and 2. Nitrogen does not appear to be an important factor in blast development when plants at a very susceptible age are growing with weather conditions extremely favorable to blast development and with an abundant supply of inoculum present.

In field 4, where only one rate of nitrogen was applied (120 pounds per acre), lesions were noted on rice only 8 days after emergence. Successive readings revealed a rapid increase in leaf blast development. Readings were incomplete, however, because of termination of field operations, but all indications pointed to probable death of all the rice as was previously experienced in field 3.

Head Blast

Head blast was confined to fields 1 and 2 (Figure 2) because the rice in the other fields was killed prior to heading. Readings were taken until there was no significant increase in head blast.

Head blast in field 1 was quite severe with 83 percent of the heads blasted. When nitrogen treatments are considered, no correlation can be made accurately concerning increased head blast due to increased nitrogen.

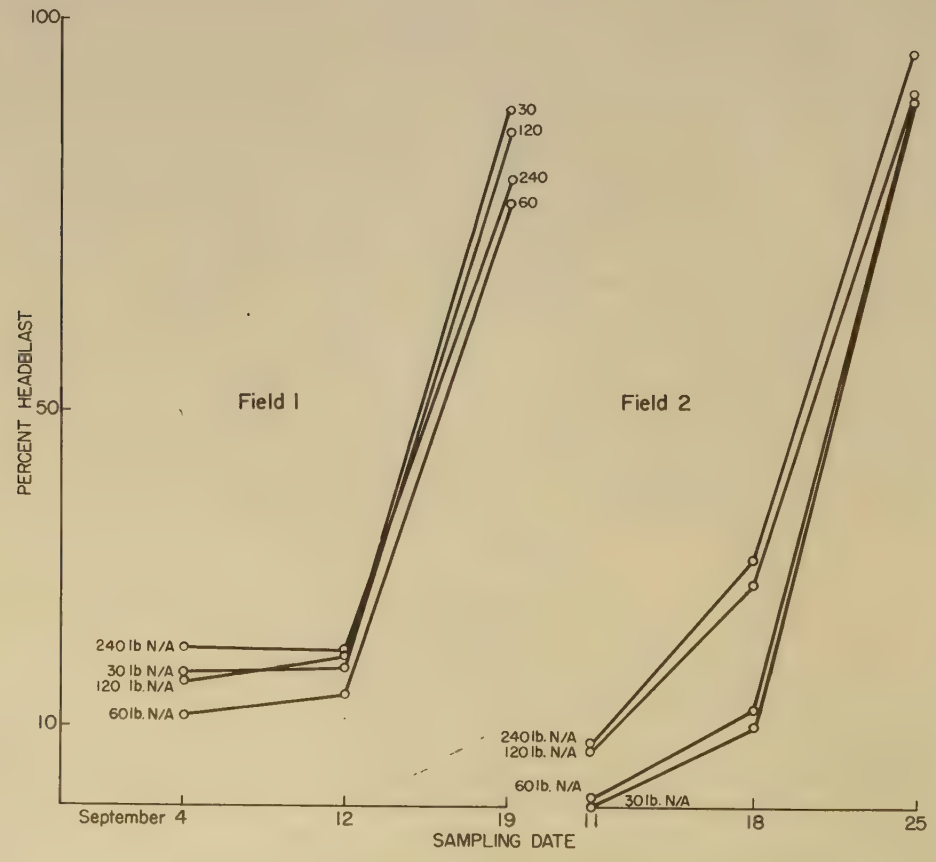

FIGURE 2. Headblast intensity.

Head blast in field 2 was even more severe, with an average of 90 percent of the heads blasted. Some correlation appears to exist between increased nitrogen and increased head blast at the time of the first two readings in the fields; however, no significant differences were found at the time the final readings were taken. From the few samples that were threshed, it appeared that 99 percent of the grain was lost from head blast in both fields.

DISCUSSION

An increase in the amount of nitrogen supplied to rice plants can result in an increase in the amount of leaf blast as has been shown by other investigators (5, 8, 9, 11, 13) and by these investigations. Increase in rice blast seems to depend not on nitrogen fertilization alone, but on the interaction of nitrogen fertilization with the amount of the inoculum present, the accompanying weather conditions, and the age of the plant.

Plants on soils receiving various increments of nitrogen but inoculated at a time when they were relatively resistant, when the amount of inoculum was low and with climatic conditions unfavorable, were not severely attacked except at the high nitrogen level (field 1). Infection of plants on the high nitrogen plot was considered the result of prolongation of the period of susceptibility of the plants by alteration of their general metabolism in such a way as to lengthen the period of active growth and production of new leaves.

Field 2 was more typical with respect to an increase in leaf blast with increase in nitrogen. This is the type of reaction that is reported by most workers. It should be pointed out, however, that the plants were exposed to a moderately increasing supply of inoculum during a period when the plants were still in an extremely susceptible period, with favorable weather conditions.

When the data of field 3 are considered, no nitrogen effect can be noted. The plants were in a very susceptible state and received an abundant supply of inoculum during favorable weather conditions, and were killed before any effect of nitrogen could be determined.

The nitrogen effect was conditioned by the stage of growth of the plant coupled with the amount of inoculum in the air and the accompanying weather conditions.

Head blast did not seem to be affected by nitrogen treatments. However, midway between seeding and maturity the nitrogen contents of soils from the four rate plots were nearly identical. It was assumed that the nitrogen had been taken up by the plants in the four plots at different rates. In support of this hypothesis it was observed that rice on plots treated with higher rates of nitrogen headed sooner than plants on plots treated with lesser amounts. Indirectly, nitrogen may play a role in head blast for, contrary to most cereal crops, rice heads earlier under high rates of nitrogen. This may be important in an area where the initial inoculum which infects heading rice would come from leaf blast lesions. Earlier heading would shorten the period of resistance from the late tillering to the heading stage and increase the chances for head blast.

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FIELD TRIALS WITH CERTAIN N-DODECYLGUANIDINE FUNGICIDES FOR THE CONTROL OF APPLE SCAB

W. D. Tunis and R. H. Sudds[1]

Summary

This report covers the performance of Cyprex at Storrs, Connecticut for the control of apple scab (Venturia inaequalis) during 1957 and 1958. That of E. F. 23441 is included for 1958 only. For both materials 1/2-100 appears to be adequate. According to the American Cyanamid Company[2] the fruit injury observed in Cyprex plots in 1957 may be associated with too high a dosage rate associated with low temperatures occurring at about the time of the Cyprex application. Cyprex appears compatible with Guthion, diazinon, Sevin, DDT, lead arsenate, Kelthane, Aramite, methoxychlor, and malathion. Cyprex 1/2-100 merits limited trials in 1959 by apple growers. E. F. 23441 was promising in 1958 but more testing is needed.

INTRODUCTION

This report presents data on the performance of certain n-Dodecylguanidine fungicides evaluated at Storrs for the control of apple scab (Venturia inaequalis). In 1957 small-scale field trials were set up to evaluate the performance of Cyprex (n-Dodecylguanidine acetate). In 1958 the Cyprex experiment was expanded to include Experimental Fungicide 23441 (n-Dodecylguanidine acid phthalate).

1957 METHODS

Plots consisted of three trees, one each of 20-year-old McIntosh, Cortland, and Red Delicious. All trees were pruned for efficient spray coverage. Each treatment was replicated four times. Sprays were applied with a 25-gallon Bean hydraulic sprayer operating at 400-500 p.s.i. Fifteen to 20 gallons of spray were applied to each tree per application. Cyprex 70W was used at the rate of 1 1/2-100 up to June 18. From June 18 on, the rate was cut to 3/4-100. Applications were made on April 23, 30; May 6, 10, 14, 20, 25; June 4, 18; July 2, 16, 29; August 12, 23. (Petal fall occurred on May 14.) From petal fall on, malathion 25W and methoxychlor 50W each at 2-100 were included in all sprays. On June 5 an apple scab index was taken in each plot. This was done by walking slowly around each tree and counting the number of apple scab leaf-lesions visible at eye level. These data are presented in Table 1.

Table 1. Apple scab leaf lesion counts of June 5, 1957.

Treatment	Average number of apple scab leaf lesions per tree		
	McIntosh	Cortland	Delicious
Cyprex	1.7	0.4	0.0
Captan[a]	2.6	0.1	0.0
Check	89.4	61.2	39.8

[a]Captan 50W included in trials as a standard treatment. Dosage rate was 2-100 up to June 18 and 1-100 after June 18. Application dates and insecticides used were the same as given for Cyprex.

Apple scab control in all plots was excellent; while the counts were being made, severe fruit injury on all varieties was noted in the Cyprex plots. This injury took the form of a single black spot on the back sides of the fruit. Approximately 20 percent of the fruit of all varieties

[1]Assistant Professor of Entomology and Associate Professor of Pomology, respectively.
[2]American Cyanamid Company. 1958. Cyprex Dodecylguanidine Acetate Technical Manual. Research Division, Stamford Laboratories, Stamford, Connecticut.

was affected. As the apples grew, the injured surface became russeted. This injury was discussed with representatives of the American Cyanamid Company, who indicated that the injury had been reported in several locations in the Northeast and that it appeared to be associated with a high dosage rate plus low temperature just prior to, during, or just after an application of Cyprex. In checking weather records of the University orchard, it was found that during the morning of May 21 the temperature had dropped to 39° F. On May 20, the day before this low temperature, an application of Cyprex had been made. While this observation appeared to corroborate the theory advanced by the American Cyanamid Company, this relationship could not be proven definitely by the Storrs observations since the date that the injury first appeared could not be pinpointed.

On September 20 harvest counts were made by examining three random bushels of hand-picked fruit from each tree in each of the three-tree replicated plots. The fruit was scored for insect, disease, and other blemishes. These data are presented in Table 2.

Table 2. Harvest counts of insect, disease, and other types of blemishes in Cyprex plots -- September 20, 1957.

Treatment	Variety	Percent clean	Percent scab	Percent light russet[a]	Percent heavy russet[b]	Percent insect damaged
Cyprex 70W	McIntosh	59.3	0.1	14.2	22.7	3.7
	Cortland	66.9	0.0	10.9	20.1	2.1
	Delicious	56.7	0.0	13.3	28.2	1.8
Captan 50W	McIntosh	90.1	0.6	6.2	1.2	1.9
	Cortland	92.5	0.0	3.7	0.7	3.1
	Delicious	86.6	0.1	9.4	1.9	2.0
Check	McIntosh	0.0	42.6	3.2	1.7	52.5

[a]Less than 10 percent of the fruit surface russeted.
[b]More than 10 percent of the fruit surface russeted.

Scab control was excellent in the Cyprex treated plots. However, the severe injury that resulted apparently from the May 20 application produced heavy fruit russet which exceeded 20 percent on all varieties tested; as a result the percent of clean fruit harvested was reduced significantly when compared with the standard captan treatment.

1958 METHODS

The experimental design and methods of application were the same as in 1957 except that E. F. 23441 was included. Cyprex 70W was used at three different rates through petal fall: 1/2, 1 and 1 1/2-100. After petal fall the 1 and 1 1/2-100 rates were reduced to 1/2-100. E. F. 23441 70W was used at the same rates as the Cyprex. The sprays were applied on April 23, 29; May 5, 8, 19, 22, 28; June 5, 12, 26; July 7, 15, 28; August 4, 21, 27. (Petal fall occurred on May 22.) The insecticides were the same as in 1957. On June 10 an apple scab index was taken in each plot. This was done by walking slowly around each tree and counting the number of apple scab leaf-lesions visible at eye level. These data are presented in Table 3.

Scab control was excellent in all treated plots. No injury of the 1957-type was observed. The lowest temperature recorded during May and June was 45° F.

On September 17 harvest counts were taken. The data on insect, disease, and other blemishes are presented in Table 4.

In 1958 scab control with Cyprex and E. F. 23441 at the three dosage levels was excellent. The lowest dosage level, 1/2-100, appeared to be just as effective for control of apple scab as the two higher rates. No injury was observed similar to that which occurred in 1957. On the basis of this single season, E. F. 23441 appears to be a very promising fungicide for the control of apple scab; it was quite similar in performance to Cyprex.

Compatibility Studies

In 1958 a test was set up to evaluate the effects of Cyprex in combination with several new and certain commonly recommended insecticides and miticides on visible tree tolerance and on

Table 3. Apple scab leaf lesion counts on June 10, 1958.

Treatment	Average number of apple scab leaf lesions per tree		
	McIntosh	Cortland	Delicious
Cyprex 70W 1/2-100	0.2	0.1	0.0
Cyprex 70W 1-100	0.4	0.0	0.0
Cyprex 70W 1 1/2-100	0.0	0.0	0.0
E. F. 23441 70W 1/2-100	0.0	0.0	0.1
E. F. 23441 70W 1-100	0.1	0.0	0.0
E. F. 23441 70W 1 1/2-100	0.0	0.0	0.0
Captan 50W 2-100[a]	0.3	0.0	0.2
Check	78.1	63.2	51.7

[a]Captan 50W was included in trials as a standard treatment. Dosage rate up to petal fall was 2-100; after petal fall, 1-100.

Table 4. Insect, disease, and other types of blemish counts made at harvest -- September 17, 1958.

Treatment	Variety	Percent clean	Percent scab	Percent light russet	Percent heavy russet	Percent insect blemish
Cyprex 70W 1/2-100	McIntosh	90.1	0.0	5.4	0.7	3.9
	Cortland	86.2	0.0	4.6	1.5	7.8
	Delicious	84.9	0.7	4.5	0.0	9.9
Cyprex 70W 1-100	McIntosh	86.4	0.0	5.3	0.7	7.6
	Cortland	82.9	0.7	4.1	0.6	11.7
	Delicious	92.3	0.0	0.0	0.6	7.7
Cyprex 70W 1 1/2-100	McIntosh	88.3	0.0	3.6	2.9	5.2
	Cortland	87.7	0.0	6.5	0.7	5.1
	Delicious	95.5	0.0	1.5	0.0	3.0
E. F. 23441 70W 1/2-100	McIntosh	89.6	0.8	6.4	0.0	3.2
	Cortland	86.6	0.0	7.0	1.5	4.9
	Delicious	86.4	0.0	7.6	0.0	6.0
E. F. 23441 70W 1-100	McIntosh	87.1	0.0	4.8	1.6	6.5
	Cortland	89.0	0.0	1.5	0.8	8.7
	Delicious	90.0	0.0	2.5	1.0	6.5
E. F. 23441 70W 1 1/2-100	McIntosh	82.7	0.0	10.8	0.0	6.5
	Cortland	85.4	0.0	5.6	1.6	7.3
	Delicious	86.3	0.0	6.8	0.0	6.9
Captan 50W 2-100[a]	McIntosh	84.5	0.9	4.4	1.1	4.9
	Cortland	86.2	0.0	3.2	0.3	6.1
	Delicious	87.4	0.2	6.1	2.1	5.2
Check	McIntosh	0.0	85.5	----	----	54.3
	Cortland	0.0	89.7	----	----	61.2
	Delicious	0.0	88.3	----	----	51.2

[a]Captan 50W included in trials as a standard treatment. Dosage rate up to petal fall 2-100; after petal fall, 1-100.

fruit finish. The combinations were applied to three-tree plots of the variety Red Delicious. The results are presented in Table 5.

None of the Cyprex combinations tested in 1958 produced visible fruit or foliage injury. Cyprex appears to be compatible with Guthion, diazinon, Sevin, DDT, lead arsenate, Kelthane, Aramite, methoxychlor and malathion.

Table 5. Effects of several combinations of Cyprex with certain insecticides and miticides on fruit finish, applied third through seventh covers[a]

Combination and dosage rate	Percent light russet	Percent heavy russet
1. Cyprex 70W 1/2-100 Guthion 25W 1 1/4-100	3.1	0.3
2. Cyprex 70W 1/2-100 Diazinon 25W 2-100	4.4	2.1
3. Cyprex 70W 1/2-100 Sevin 50W 2-100	2.9	1.2
4. Cyprex 70W 1/2-100 DDT 50W 2-100	4.1	2.4
5. Cyprex 70W 1/2-100 Lead arsenate 3-100	5.6	3.1
6. Cyprex 70W 1/2-100 Kelthane 18.5% 1 1/2-100 DDT 50W 2-100	1.2	0.9
7. Cyprex 70W 1/2-100 Aramite 15W 1 1/2-100 DDT 50W 2-100	1.7	1.4
8. Cyprex 70W 1/2-100 DDT 50W 2-100 Lead arsenate 2-100	3.3	2.9
9. Cyprex 70W 1/2-100 Methoxychlor 50% 2-100 Malathion 25W 2-100	4.5	0.0
10. Cyprex 70W 1/2-100	3.4	1.6

[a]Treatments prior to second cover were as follows: five applications of Cyprex 1/2-100, (April 23, 29; May 5, 8, 19). Cyprex 1/2-100 plus Dieldrin 50W 1/2-100 petal fall through second cover (May 22, 28; June 5, 12). Application dates of 3rd through 7th covers: June 26; July 7, 15, 28; August 4, 21.

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EFFECTIVENESS OF CERTAIN PROTECTANT FUNGICIDES FOR CONTROLLING PECAN SCAB DURING A SEVERE SCAB SEASON IN OKLAHOMA

George L. Barnes[1]

Summary

Four protectant spray materials were tested on Squirrel pecan trees for control of scab on foliage and nuts during the severe scab season of 1958. Dyrene and zineb provided excellent relative control, maneb gave poor control, and ziram was relatively ineffective. Weight of nuts increased proportionately with the number of applications of ziram in a spray-omission test on Western trees.

INTRODUCTION

Pecan scab, incited by Fusicladium effusum Wint., is a limiting factor in the production of pecans from improved varieties. Native trees also are affected during severe scab seasons. Proper timing and application of effective fungicides and strict adherence to good sanitation practices such as orchard thinning and disking under of fallen diseased plant materials will greatly facilitate the control of scab as well as other diseases.

In the humid southeastern States, low-lime Bordeaux mixture alone or followed by applications of ziram or zineb is recommended for scab control (2, 3, 4, 6). Bordeaux mixture, however, is not recommended in the southwestern States because of its phytotoxicity during dry weather (4). Zineb is the currently recommended fungicide in Oklahoma and Texas (1, 19).

Various dithiocarbamate fungicides have been tested for control of pecan scab by various workers with varied results during wet and dry seasons. Maneb and zineb gave better control than ziram in tests by Converse (7) during the dry season of 1953 in Oklahoma, but, of five materials tested in the wet 1957 season, none gave significantly better control than ziram (8). Ferbam has been found to be equal to, or less effective than, ziram (10, 16, 18). Zineb was more effective than ziram, ferbam, and Bordeaux mixture in the 1950 wet season tests by Rosberg (18) in Texas. After many years of testing, Large (13, 15) found that maneb, ziram, and ferbam are ineffective during wet seasons in Florida.

Most workers have followed a 3- to 4-week application schedule, probably as a compromise between the frequency of applications required for good control and what the growers feel they can afford. Results frequently have been unsatisfactory because of a number of factors. The incubation period of the fungus averages only 10 days (9). In addition, the effectiveness of pesticide deposits rapidly diminishes as a result of erosion by rains and dew, brushing by foliage, thinning and breaking of the deposit by tissue growth and possible decomposition by high temperatures and strong sunlight (11, 17). Improper timing, infrequent applications, and poor coverage also will result in poor control even with good fungicides.

MATERIALS AND METHODS

Wettable-powder formulations of four fungicides were used in two types of experiments. One experiment was designed to evaluate the relative effectiveness of the materials for scab control. The second one was a spray-omission test designed to yield data for determining when applications should begin and the frequency required for scab control.

The materials used in the first test were Parzate[2] (65% zineb, E. I. duPont de Nemours & Co., Inc.), Dyrene (50% 2,4-dichloro-6-(0-chloroanilino) -s-triazine, Chemagro Corporation), Manzate (70% maneb, E. I. duPont de Nemours & Co., Inc.) and Zerlate (76% ziram, E. I. duPont de Nemours & Co., Inc.). Zerlate was selected for the spray omission experi-

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[1]Agent (Plant Pathologist), Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and Assistant Plant Pathologist, Oklahoma Agricultural Experiment Station, Stillwater. The author gratefully acknowledges the use of pecan trees at the George Spraberry farm, Paden, Oklahoma, and the assistance of Ralph Molsbee, farm operator.

[2]Brand names are used for clarity only and no endorsement is intended, nor is criticism implied of similar products which were not used.

ment because of its relatively low cost and good performance in previous years. All materials were used at 1.5 pounds of toxicant per 100 gallons of mixture. Deenate (50% DDT, E. I. duPont de Nemours & Co., Inc.) was included at the appropriate times for control of case-bearers, walnut caterpillars, and pecan weevils.

Applications were made with a conventional hydraulic high-pressure spray machine at 2- to 4-week intervals, the interval depending on weather conditions. The trees were circled and approximately 20 gallons of spray material was applied to each tree at each spraying date. An April application was planned but could not be made because of a sprayer malfunction. Consequently, some primary lesions were visible on the foliage when the first application was made in early May. Single-tree plots of 26-year-old Western and Squirrel trees were replicated five times for each treatment. The trees are on the George Spraberry farm near Paden, Oklahoma.

The inoculum carryover from 1957 was moderate. Rains and dew occurred frequently during the entire season and many days and nights were favorable for infection of foliage and nuts. Approximately 30 inches of rain fell in the Paden area on 57 rainy days (0.1 inch and over) between April 1 and September 30. Because relative humidities were high, dew frequently formed on foliage at night. Cole (5) and Large (14) have demonstrated the difficulty in controlling scab under such conditions in the Southeast.

Table 1. Effectiveness of protectant fungicides for controlling scab on Squirrel pecan trees in Oklahoma during 1958.

Fungicide[a] (1.5 pounds active ingredient/100 gallons mixture)	Weight of 50 nuts with shucks[b] (grams)	Average shuck surface scabbed[b] (percent)	Nuts per pound (11/21) (number)
Dyrene	269.9	22	113
Zineb	222.9	20	114
Maneb	123.9	60	162
Ziram	36.4	96	207
None	10.4	100	---[c]

[a]Eight applications (5/7, 6/2, 6/27, 7/9, 7/30, 8/12, 9/2, and 9/18).
[b]Ten nuts from each of five trees per treatment. Samples obtained on 10/6.
[c]Nuts were so diseased and small and had such tightly adhering shucks that samples could not be obtained.

Table 2. Effect of timing and frequency of applications of ziram[a] for control of scab on Western pecan trees in Oklahoma during 1958.

Date of first spraying	Total applications (number)	Weight of 50 nuts with shucks[b] (grams)	Average shuck surface scabbed[b] (percent)	Nuts per pound (11/21) (number)
5/5	8	155.8	69	97
6/2	7	174.2	70	118
6/23	6	114.6	79	---[c]
7/9	5	133.1	81	114
7/30	4	114.7	86	145
8/12	3	117.2	88	156
None	0	89.4	95	---[d]

[a]One and one-half pounds of active ingredient per 100 gallons of mixture.
[b]Ten nuts from each of five trees per treatment. Samples obtained on 10/6.
[c]Sample inadvertently not collected.
[d]Nuts were so diseased and small and had such tightly adhering shucks that samples were not collected.

The average percentage of total scabbed surface on nut shucks was determined for a 10-nut random sample from each of five trees per treatment on October 6. The average number of nuts per pound for each treatment was determined on November 21.

RESULTS

Of the materials tested on Squirrel trees, Dyrene and zineb provided the best protection against the pecan scab fungus under severe epiphytotic conditions (Table 1). Maneb performed very poorly and ziram was relatively ineffective. A few lesions appeared on the shucks of nuts sprayed with the two better materials, apparently because of the lateness of the first spray application and the long intervals between applications. Nuts from all trees were light, but the heaviest ones came from the Dyrene- and zineb-sprayed trees.

In the spray-omission experiment with ziram applications on Western trees, all nut shucks were very scabby and the nuts were very light (Table 2). The heavier nuts, however, came from those trees which received the earlier and greater number of applications. Initiation of spray applications very early in the season is indicated. The scab-control results of the first test are similar to those obtained by Large (15) in wet seasons in Florida and indicate that maneb and ziram fungicides are ineffective during wet seasons in Oklahoma.

Dyrene and zineb warrant further evaluation as protectant fungicides for scab prevention in Oklahoma. Zineb is recommended for use in Oklahoma because of its past and present good performance. Of additional interest are the reports that zineb suppresses pecan mite and aphid populations in Texas (12, 18). Additional research is required before the new experimental fungicide, Dyrene, can be considered for recommendation. Dyrene may also be useful as a dormant-season fungicide. Short-time immersions by Converse (8) of stromatic colonies of F. effusum in a Dyrene suspension, equivalent to 8.3 pounds per 100 gallons of water, killed the fungus. Because of this eradicant action, Dyrene should be evaluated as a dormant-season eradicant spray material.

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ZINEB SHOWS PROMISE FOR THE CONTROL OF LEAF SPOT OF BULBOUS IRIS[1]

Charles J. Gould[2]

Abstract

In spraying tests in western Washington in 1958, the most effective control of Didymellina leaf spot of bulbous iris was obtained with applications of zineb and bordeaux mixture. Sprays of Phaltan, captan, ferbam, and Tri-Basic copper sulfate were next in order of merit.

INTRODUCTION

Leaf Spot or Fire (caused by Didymellina macrospora Kleb.) is probably the most serious disease of bulbous iris in the major bulb-producing countries (United States (11), England (4), Holland (19), and Canada (2)). It has been reported from enough other areas (16) to indicate that it is worldwide in distribution.

In the early years of Pacific Northwest iris culture the disease was a serious handicap to production. However, McWhorter (15) in 1936 and Huber (12, 13) in 1937 reported promising results with a combination spray of bordeaux mixture (8-8-100) plus Penetrol sticker. Bulb growers rapidly adopted its use, with generally good results until the last few years.

The severe attacks that have occurred recently may have been caused by: 1) a change in climatic conditions; 2) carelessness in proper sanitation and rotation measures; 3) substitution of other spreader-stickers for Penetrol, which had become unavailable; 4) development of new strains of the fungus, or, most likely, a combination of some of these factors, particularly #1 and #2. The following experiment was run, therefore, in an effort to find a fungicide more effective than bordeaux mixture and, if possible, one easier to prepare.

METHODS AND MATERIALS

Wedgwood iris bulbs (200 8 to 9 cm rounds) were planted in October 1957 in a randomized block on silt loam. Six replications were used per treatment. Rye was planted in rows between plots and around the perimeter of the entire area to decrease air movement and increase the relative humidity. In addition, rainfall was supplemented by overhead sprinkling to increase disease development in early spring. Naturally-infected iris leaves (from 1957 and 1958 collections in commercial fields) were scattered uniformly among the plants on April 1 to provide a source of inoculum. Eight sprays were applied (@ 30 pounds' pressure) on the following dates in the spring of 1958: April 1, 11, 23; May 6, 20; June 3, 17; and July 1. Applications were made at 14-day intervals with the exception of the first ones in which 10- and 12-day intervals were used since the rainfall was unusually heavy during that period.

On June 13 the second oldest leaf was removed from each of 50 average plants in each plot. These were grouped into 10 classes, based upon the percentage of dead area (0 -- 10 percent, 11 -- 20 percent, and so forth). The average figure thereby obtained for each treatment is shown in Table 1. The bulbs were harvested on August 1 and data obtained on weight, size, and so forth. The most important data concerning these are also listed in the table.

Duncan's (10) test for significance between means has been applied to these data, rather than the LSD, because several treatments were involved.

RESULTS AND DISCUSSION

Never before had the leaf spot disease been serious on the experimental farm where the tests were made. The extra precautions already described, therefore, were taken to insure adequate disease development. Unfortunately, the climatic conditions became so favorable for fungus growth that, after a slow start, it spread extremely rapidly and destructively. April was wetter than normal, and May and June were unusually warm. By June 1st almost every

[1]Scientific Paper No. 1813, Washington Agricultural Experiment Stations. Work was conducted under Project No. 422.

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leaf was infected with one or more spots and by the end of June most of the leaves were dead. However, leaves sprayed with Parzate and, to a lesser extent, those sprayed with bordeaux mixture stayed alive much longer than did the others. The leaf samples measured on June 13 showed that leaves sprayed with Parzate or bordeaux had significantly less diseased area than those treated with other fungicides (Table 1). Tri-Basic copper sulfate gave the poorest results.

Table 1. Percentage of dead leaf area on June 13 and yield of iris bulbs in grams. Data taken from western Washington plots sprayed eight times in spring of 1958 for control of Didymellina leaf spot.

Fungicide	Rate in pounds per 100 gallons	Spreader	Rate per 100 gallons (ounces)	Percent of dead leaf area on June 13	Average yield of bulbs in grams: Rounds	Average yield of bulbs in grams: All bulbs
None	-	-	-	68.0	1405	3285
Bordeaux	8-12	DuPont Sp. St.	2	53.9[a]	1450	4232
Tri-Basic copper sulfate[b]	4	"	2	73.3	1435	3681
Fermate (76% ferbam)	2	"	2	62.4	1638	3917
Parzate (65% zineb)	2	"	2	45.7[a]	2148[a]	4144
Orthocide 50 W (50% captan)	2	Ortho	8	59.8	1523	3361
Phaltan 50 wettable[c]	2	"	8	58.1	1604	3463
"F" Value (required for significance = 2.38 @ 5% & 3.38 @ 1%)				6.65	2.52	1.80

[a]Data significantly different from other means not marked with 'a' at the 5% level of significance (by Duncan's method).
[b]53% metallic copper.
[c]50% N-trichloromethylthiophthalimide.

Since the leaves were killed when the bulbs were just beginning to make their maximum growth, the leaf data are considered to be more indicative of the effectiveness of the fungicides under normal conditions than are the bulb yield data. Differences in bulb yield between the various sprayed and unsprayed plots are not as large as expected, although all were better than the check (Table 1). The total yield was largest in the bordeaux and Parzate plots, followed by Fermate, Tri-Basic copper sulfate, Phaltan, Orthocide, and the unsprayed.

The yield of round bulbs is particularly interesting. ("Rounds" are the type usually sold for greenhouse forcing.) In this experiment the yield by weight of round bulbs was significantly higher in the Parzate-sprayed plots than in any other. The total number of rounds and also the number of large rounds (9 cm and larger) were also much higher. An increased production of round bulbs would be of considerable value to the growers. Although the results with Parzate are significant at the 5 percent level, we should have even stronger evidence that they are not due to chance. Field-grown Wedgwood iris bloomed about April 15th in the Puyallup area in 1958. The flower embryo was presumably already well formed by April 1st, the date on which spray applications were started. It is possible that the fungicide suppressed further flower development, but it does not seem probable.

Most of the results with Didymellina macrospora reported in the literature deal with the disease on bearded iris. Moore lists several articles in which bordeaux mixture is reported as both effective and non-effective. Maxwell (14) found bordeaux and sulfur sprays effective, but a sulfur dust was less effective. Bordeaux, lime-sulfur and solbar were all described as effective in Germany (1). Sadler (17) reported unsuccessful results with colloidal copper sprays. In Austria, Schmidt (18) stated that the disease could be prevented with copper, sulfur or thiocarbamate preparations. In 1952, Dimock (5, 6) reported poor control with Zerlate, Fermate, Crag 341C, Crag 341 Sc, Tag 331, Orthocide 406, Phygon XL, Vancide 51, Geary 4255 and COCS; and good control with Dithane Z-78, Crag 5400, Crag 5379, Puratized Agricultural Spray and Bioquin 1. In 1954 (7) he commented that "zineb also takes top billing for ..... iris leafspot" and in 1958 (9) he reported that Phaltan controlled the disease. In a personal communication, Dimock (8) stated that bordeaux mixture also gave good control but that it and other copper compounds were phytotoxic to rhizomatous iris in New York.

The most important previous reports of experiments on bulbous iris were those by McWhorter in 1936 (15) and Huber in 1937 (12, 13). Both scientists stated that several fungicides had been tested, but neither listed all of those tried. As a result of their tests McWhorter and Huber recommended the mixture of bordeaux plus Penetrol sticker. Beaumont (4) reported that bordeaux, plus stickers, failed to check epidemics in southwestern England in certain years and that dusting with copper or sulfur fungicides was completely ineffective. The only successful control measure under those conditions was the removal of infected leaves with scissors, which is obviously impractical in commercial practice. The latest Dutch recommendations (3) are for either zineb or maneb.

In view of the experimental results here and reports elsewhere, the standard recommendation for use on Washington-grown iris will continue to be bordeaux mixture, plus a suitable wetting and sticking agent, but with zineb suggested for large scale commercial trial during the 1959 season. Bi-weekly applications of both materials should be made during leaf spot weather. For satisfactory control, however, the fungicides must be used in conjunction with other standard precautions, particularly those of proper rotation and sanitation (11).

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SPRAYS FOR CONTROL OF POWDERY MILDEW OF ROSES

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Combination sprays and dusts for the control of pests on field-grown roses have been studied since 1950. The experiment reported herein, however, was the first concerned primarily with the control of powdery mildew (Sphaerotheca pannosa (Wallr.) Lev.), which usually becomes a pest on outdoor roses in the Beltsville, Maryland area for a short period during September and early October. The disease is rarely serious in the summer and is generally limited to locations with poor air drainage.

METHODS

The experiment was conducted in four blocks of 30 plots each, arranged in a randomized block design. Each plot contained three plants of Helen Traubel[3] rose and three of Red Radiance[3] planted 2 1/2 feet apart, mulched with 1 to 2 inches of sawdust, and fertilized uniformly at regular intervals. During the summer all plots had received a multi-purpose combination spray applied weekly for control of blackspot, mites, and insects. Zineb at the rate of 2 pounds per 100 gallons of tap water for control of blackspot had been the only fungicide applied. On September 15, 1958 sprays were discontinued.

During the first week in October powdery mildew began to appear and applications of each of 15 sprays were made on October 10, October 13, and October 16, 1958. In Table 1 the composition of these sprays and the rates of application for each chemical are recorded. In each

Table 1. Ratings[a] of 15 fungicides or fungicide combinations applied three times for control of powdery mildew of Helen Traubel and Red Radiance roses, Beltsville, Maryland, 1958.

Rank	Treatment	Grams active ingredient per 100 gallons water (in grams)	Rating
1	Phaltan[b]	908	3.50
2	Omazine + thiram	339; 454	4.63
	Sulfur + thiram	908; 454	4.63
3	Acti-dione PM + thiram	76.1; 454	4.69
	Karathane + thiram	908; 454	4.69
4	Karathane	908	4.81
5	Acti-dione PM + Karathane	76.1; 908	4.88
6	Acti-dione PM	76.1	5.06
7	Acti-dione PM + Omazine	76.1; 339	5.19
	Sulfur	908	5.19
8	Anisomycin	75.7	5.31
	Thiram	454	5.31
9	Omazine	339	5.56
10	Control[c]	None	6.25
11	Thiram	908	6.93

[a]See explanation in text.
[b]LSD for comparison of Phaltan with other treatments 1.17.
[c]LSD for comparison of sprays with the unsprayed control 1.35.

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[3]The authors acknowledge Armstrong Nurseries of Ontario, California for the variety Helen Traubel and Vermay Nursery, Hand Rose Farms, McClung Nursery, and Atwood Rose Nursery of Tyler, Texas for the variety Red Radiance.

of the four blocks 15 plots received sprays and the sixteenth served as ar unsprayed control. The other 14 plots, which showed 73 percent infection, were not included in the experiment. Phaltan was not used in combination, but in each block it was applied to two plots at the rate of 908 grams (2 pounds) per 100 gallons. On October 30 the plots were rated independently by each of four investigators, who used a scale of 0 to 10: 0 indicated no powdery mildew, 10 infection of every leaf in the plot, and 1 through 9 the approximate percent of leaves in the plot infected with powdery mildew.

RESULTS

The averages for the four ratings are reported in Table 1. Phaltan resulted in the best control of powdery mildew as the average of the two treatments (Table 1). Phaltan alone and the chemicals combined with thiram at 454 grams (1 pound) per 100 gallons of water gave more effective control than any of the chemicals alone or these chemicals in combination with a compound other than thiram. These materials, as well as Karathane and Karathane combined with Acti-dione PM, gave significant control of powdery mildew as compared with the control. The other sprays were not effective. None of the formulations used gave excellent control.

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EXPERIMENTS WITH CAPTAN AND FERBAM AS SYSTEMICS FOR CONTROL OF BACTERIAL ROT OF SAGUARO AND ORGAN-PIPE CACTUS

Curtis May and John G. Palmer[1]

Summary

No evidence was obtained that ferbam was absorbed from soil by organ-pipe cactus plants or that it diffused into unwounded tissue following direct injection as a dry powder into a freshly made cavity. On the other hand, captan or an alteration product of it entered saguaro plants growing in treated soil. Treatments with captan or ferbam did not prevent development of rot in the inoculated plants.

A soft rot of saguaro, Carnegiea gigantea (Engelm.) Britt. & Rose, and organ-pipe cactus, Pachycereus marginatus (DC.) Britt. & Rose, is widely distributed and destructive in southwestern United States. In some localities the disease is an important factor in the deterioration of native cactus forest. Also both species are commonly used in landscape plantings in the area. Protective treatment by injection of chemicals into cultivated plants or plants of special importance in parks and elsewhere would be practicable, but probably would be too costly to use in large native stands.

The results of attempts to use captan and ferbam as systemics to protect young saguaro and organ-pipe cactus plants from bacterial rot are presented here. The rot of saguaro is caused by a bacterium, Erwinia carnegieana Standring.

EXPERIMENTS WITH CAPTAN

On December 2, 1957, 14 four-year-old plants of Carnegiea gigantea growing in 4-inch pots in the greenhouse were treated by scratching 3.75 grams of captan into the top 1/2 inch of soil. This dosage is approximately equal to a rate of 5 pounds per 25 square feet of soil surface. Ten untreated plants served as controls. Residues of acetone extracts made from five treated plants 7 days after treatment inhibited growth of Ceratocystis ulmi (Buisman) C. Moreau in vitro. Extracts from control plants did not inhibit the fungus. The sensitivity of C. ulmi to captan and the techniques used in the bioassay were discussed in previous publications[2].

The nine remaining treated plants were inoculated with E. carnegieana 2 weeks after treatment with captan. Rot developed in all of the inoculated plants. Captan at dilutions of 1-1000 or greater did not inhibit growth of E. carnegieana in vitro.

EXPERIMENTS WITH FERBAM

Ferbam at the rate of 5 pounds per 25 square feet of surface was added January 17, 1958 to soil in pots in which seedlings of the organ-pipe cactus approximately 6 inches in height were already established. On May 16 residues of acetone extracts of 10 grams of treated soil tested by bioassay were fungitoxic to C. ulmi in vitro. Similarly prepared and tested residues from untreated soil were not fungitoxic. On May 27, 1958 treated plants and controls were inoculated by injection of approximately 0.5 ml of a suspension of E. carnegieana. Within 2 weeks 57 percent of 21 treated plants and 25 percent of 24 untreated plants developed typical bacterial rot. Uninoculated, ferbam-treated plants remained normal.

Acetone extracts were made from treated plants. The extracts were concentrated and tested by bioassay for fungitoxicity to C. ulmi. The extracts were not fungitoxic. However, tests demonstrated that a concentration of 1 ppm of ferbam was fungitoxic to C. ulmi in vitro and that at a concentration of 1 to 1000 it inhibited growth of E. carnegieana in vitro. Failure of extracts of the treated cactus plants to inhibit growth of C. ulmi in vitro suggested either

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[2] For techniques used in these tests see May, Palmer and Hacskaylo. 1958. Plant Disease Reptr. 42: 696-702, and 42: 399-401.

that ferbam had not entered the plants, was not present in sufficient amounts to be fungitoxic, or was altered to a non-toxic compound within them.

Further study was made to determine whether ferbam would have systemic action if it gained access to the cactus plants. Thirty organ-pipe seedlings approximately 6 inches in height were impregnated with ferbam as follows: the surface of each plant was washed at the site of impregnation with 70 percent alcohol. Then a sterile cork borer was inserted into the mesophyll near the base of some plants and near the top of others. The tissue inside the cork borer was macerated. Half a gram of dry ferbam was placed in the cavity of each plant. A cork was then placed in each hole. The plants were treated on October 28, 1958. They sat on the greenhouse bench until inoculated on January 27, 1959. Approximately 0.5 ml of an 18-hour culture of E. carnegieana was injected by hypodermic needle into each plant[3]. All inoculated plants developed typical bacterial rot within 10 days. Plants injected with sterile distilled water remained healthy.

Examination of the diseased plants showed that ferbam was still present at the locus of treatment. No observable callous tissue had developed around the wounds. Apparently the ferbam had not moved from the site of application. Sections of the treated plants were tested by bioassay to determine the validity of this hypothesis.

The plants were cut off at the base and then rinsed by pouring 70 percent alcohol over them to remove fungicide from their surfaces. Each plant was then cut into sections 1/4 to 1/2 inch thick beginning at the end farthest from the locus of treatment. A sterile cork borer was then used to cut a plug from each of the sections. The plugs were placed on the surface of hardened agar containing approximately 15,000 spores of C. ulmi per ml. Plates were incubated at 21° C for 4 days and then observed. Growth of C. ulmi was not inhibited except in plates containing a section of cactus cut through the locus of impregnation and on which ferbam was readily observable. Neither ferbam nor a fungitoxic product of it was present in the unwounded cactus tissue or at least had not penetrated 1/4 inch into it. Failure of the ferbam to become distributed in the cactus plants explains its failure to control the rot.

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3 The authors thank Stanley Alcorn for supplying the inoculum and inoculating the plants.

NEW AND UNUSUAL LEAF DISEASE FUNGI FOR ILLINOIS

Dan Neely[1]

From leaf disease material collected by members of the Natural History Survey staff and from material mailed to this laboratory for diagnosis during 1958, a number of fungi are being recorded for the first time for Illinois. The determinations are based on material now in the Mycological Collection of the Illinois State Natural History Survey. After referring to the indices of Saccardo (1), Seymour (2) and Weiss (3), it is believed that four of these determinations give new host records for the United States. (Table 1).

Table 1. Leaf disease fungi found for the first time in Illinois.

Fungus	Host	Collected: Place	Collected: Date
Actinopelte dryina (Sacc.) Höhn.	Quercus falcata Michx.	Dixon Springs	August 13
Coniothyrium pirinum (Sacc.) Sheldon	Crataegus mollis (T.&G.) Scheele[a]	Lisle	July 15
Diplodia pinea (Desm.) Kickx.	Pinus mugo Turra	Monticello	Dec. 12
Diplodia pinea (Desm.) Kickx.	Pinus nigra Arnold	Galesburg	Nov. 18
Epicoccum purpurascens Ehrenb.	Gingko biloba L.[a]	Lisle	July 15
Gloeosporium sp.	Cotinus coggygria Scop.[a]	Champaign	July 16
Gloeosporium quercinum West.	Quercus stellata Waugh.	Cave in Rock	August 13
Kunkelia nitens (Schw.) Arth.	Rubus ostryifolius Rydb.	Shawneetown	May 7
Marssonina ribicola (Ell. & Ev.) Magn.	Ribes alpinum L.	Flossmoor	July 29
Marssonina toxicodendri (Ell. & Martin) Magn.	Rhus glabra L.	Makanda	August 13
Microsphaera alni DC. ex Wint. var. vaccinii (Schw.) Salm.	Catalpa speciosa Warder	Onarga	August 7
Monochaetia desmazieri Sacc.	Quercus marilandica Muench.	Dixon Springs	August 13
Mycosphaerella mori (Fckl.) Lindau	Morus alba L.	Charleston	August 12
Pestalotia guepini Desm.	Cercis canadensis L.[a]	Charleston	August 12
Phyllosticta viticola (Berk. & Curt.) Thuem.	Vitis riparia Michx.	Momence	June 20
Puccinia panici Diet.	Euphorbia corollata L.	Momence	June 20
Puccinia peridermiospora (Ell. & Tracy) Arth.	Fraxinus pennsylvanica Marsh.	Urbana	July 10
Puccinia peridermiospora (Ell. & Tracy) Arth.	Fraxinus americana L.	Champaign	June 3
Septoria aceris (Lib.) Berk. & Br.	Acer negundo L.	Cave in Rock	Aug. 13
Sphaeropsis cruenta (Fr.) Gilman & Archer	Smilacina racemosa (L.) Desf.	Momence	June 20
Stagonospora pini Grove	Juniperus virginiana L.	Onarga	Mar. 4

[a]New hosts for the United States.

Of the four fungi on hosts believed new to them in the United States, Epicoccum purpurascens on maiden hair tree and Coniothyrium pirinum on downy hawthorn were found at the Morton Arboretum near Lisle, Illinois. Gloeosporium sp. on smoke tree and Pestalotia guepini on redbud were found on private estates near Champaign and Charleston, Illinois, respectively. The leaf spots on maiden hair tree were irregular, 3 to 10 mm in diameter, had an ashen gray to brown center with a definite purple margin. The fungus fruiting bodies were amphigenous and morphologically indistinguishable from Epicoccum purpurascens Ehrenb. On downy hawthorn the spots were small, tan to brown and irregular, 2 to 4 mm in diameter with a definite margin. They usually were found along a leaf vein and occasionally were elongate. Pycnidia were scattered and amphigenous. The fungus is characteristic of Coniothyrium pirinum (Sacc.) Sheldon. The Gloeosporium sp. on smoke tree was found fruiting on a tree that was diagnosed

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as having Verticillium wilt. The leaf blotch began at the tip and margins and progressed toward the base of the leaf blade. Acervuli were abundant on the lower surface of the browned area. The leaf spots on redbud were brown, irregular and variable in size, from 3 to 30 mm in diameter, and often appearing on the leaf margin. The acervuli were amphigenous and the fungus was identified as Pestalotia guepini Desm.

Table 2. Leaf disease fungi of infrequent occurrence but present in Illinois in 1958.

Fungus	Host	Collected	
		Place	Date
Actinopelte dryina (Sacc.) Höhn.	Quercus marilandica Muench.	Dixon Springs	August 13
Cercospora rhoina Cke. & Ell.	Rhus glabra L.	Cave in Rock	August 13
Gloeosporium affine (Ell. & Kell.) Ell. & Ev.	Sassafras albidum (Nutt.) Nees	Villa Ridge	May 28
Marssonina thomasina (Sacc.) Magn.	Euonymus atropurpureus Jacq.	Beardstown	August 30
Septogloeum profusum (Ell. & Ev.) Sacc.	Ulmus americana L.	Schram City	August 30
Uncinula macrospora Pk.	Ulmus alata Michx.	Makanda	August 13

Fungi of unusual occurrence are listed in Table 2. Although they have been previously reported as being present in the State, it is of interest that they were again found during 1958. For Actinopelte dryina on black jack oak, Marssonina thomasina on wahoo and Septogloeum profusum on American elm, this is only the second collection in 35 years by members of the Natural History Survey staff.

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SOME PLANT DISEASES OBSERVED IN MEXICO IN 1958[1]

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The following is a report of plant diseases observed and identified in Mexico in 1958 by the authors. Disease problems were more pronounced than usual owing to the abnormally heavy rainfall experienced throughout the Republic during the summer and fall. This list is by no means complete; however, it does present some information on the disease situation.

COTTON

Except as noted, the reports on cotton are limited to the irrigated area of the State of Sonora which comprises the Yaqui Valley.

Damping-off -- Rhizoctonia solani Kuehn. Found generally in the area. Especially affected were the early plantings made in cool weather, many of which had to be replanted in part.

Fusarium wilt -- Fusarium oxysporum Schlecht. f. vasinfectum (Atk.) Snyder & Hansen. Only a few plants were affected. This disease was of minor importance in 1958.

Verticillium wilt -- Verticillium albo-atrum Reinke & Berth. Same as Fusarium wilt. This disease was very destructive in the Laguna region near Torréon, Coahuila.

Texas root rot -- Phymatotrichum omnivorum (Shear) Dug. Only small localized areas were observed in the Yaqui Valley. In Huatabampo and in the Mayo River area larger areas were found, and some farmers lost up to 10 percent of their crop.

Rust -- Puccinia cacabata Arth. & Holw. (P. stakmanii Presley). This disease was of common occurrence throughout the valley. The areas of highest incidence were those adjacent to the prairie where the alternate hosts Bouteloua aristidoides, B. arenosa, B. curtipendula, and B. gracilis are endemic. Since the principal attack of the disease occurred when the plants were almost mature, yields were not affected. The amount of natural inoculum as teliospores on the aforementioned grasses represents a potential danger every year, the actuality depending on rainfall conditions during the early summer.

Leaf blight -- Ascochyta gossypii Woron. The early plantings made during cool, moist weather showed many plants with blighted cotyledons and leaves. In general, these plants recovered with the onset of warmer, drier conditions.

Leaf spot -- Cercospora althaeina Sacc. Of same occurrence and importance as leaf blight.

Anthracnose -- Glomerella gossypii Edg. This disease appeared at the time of boll formation but was of no economic importance.

Boll rot -- Diplodia gossypina Cke. Bolls located on the lower, shaded parts of the cotton plants were affected; a great number of these were damaged in 1958.

CORN

Seedling blight -- Fusarium sp., Pythium sp. In the Central Mesa and in the Bajio there was some reduction in stand due to seedling blight. For the first time in 10 years seed treatment gave significant improvement in stand.

Leaf blight -- Helminthosporium turcicum Pass. Observed generally throughout Mexico. Was severe on January plantings in Veracruz. H. maydis Nisik. & Miyake was present also in Veracruz but to a minor extent.

Smuts -- Sphacelotheca reiliana (Kuehn) Clint. Was present in the Bajio and in Veracruz. In the Bajio a few farms had up to 40 percent incidence in their corn. This represented a direct loss to the grower. Ustilago maydis (DC.) Cda. was observed in most areas but was of little importance. It is interesting to note that in many areas of Mexico immature corn smut galls are gathered and eaten as a foodstuff.

False smut -- Ustilaginoidea virens (Cke.) Tak. was observed in the Veracruz area but was of no importance economically.

Dry ear rot -- Diplodia zeae (Schw.) Lév. Noted throughout the country, its importance related to the moisture conditions at the time of maturity.

Rust -- Puccinia sorghi Schw. This disease was widespread but caused little economic loss.

Brown spot -- Physoderma maydis Miyabe. This disease was observed in the State of Veracruz but was of minor importance.

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Corn stunt -- The corn stunt disease (virus) was observed both in the northwest and in Veracruz. In the latter area the disease was severe and affected a large percentage of plants in breeding plots; in fields of criollo (native) corns, however, it was of minor importance.

SORGHUM (MILO)

Leaf blight -- Helminthosporium turcicum Pass. Caused almost complete defoliation of a small experimental planting (winter) at Veracruz. This disease was also observed in other areas but was not important.

Smut -- Sphacelotheca reiliana (Kuehn) Clint. Occasional plants were attacked in the irrigated areas of the State of Sonora. Damage was slight. Especially affected were Hegari and Shallu grass.

Rust -- Puccinia purpurea Cke. This disease was found throughout the country where milo was grown, but was of little economic importance.

WHEAT

Stem rust -- Puccinia graminis Pers. f. sp. tritici Eriks. & E. Henn. No stem rust was observed in the northwest area of Mexico owing to the universal use of rust-resistant wheat varieties. In the central (Bajio) region and in the Central Mesa, stem rust was observed in the native (criollo) wheat varieties.

Leaf rust -- Puccinia recondita Rob. (P. rubigo-vera (DC.) Wint.). This disease occurred throughout the wheat-raising areas of Mexico. In general, losses due to this rust were of no great importance. However, leaf rust is now the most important disease of wheat, since varieties resistant to stem and stripe rust are extensively cultivated.

Stripe rust -- Puccinia striiformis West. (P. glumarum (Schm.) Eriks. & E. Henn.) This disease was severe on old "native" wheats at elevations of 3500 feet and above in northern and central Mexico. Rarely found on the coast of Sonora because of unfavorable temperatures.

Bunt -- Tilletia caries (DC.) Tul. Encountered in several of the wheat areas, especially where the old native (criollo) wheats were grown.

Downy mildew -- Sclerospora macrospora Sacc. This was found in low, salty spots in some fields in the Yaqui and Mayo Valleys, but was of little economic importance.

RYE

Leaf scald -- Rhynchosporium secalis (Oud.) J. J. Davis. This disease caused considerable damage in experimental plantings in the Toluca Valley, State of Mexico.

FLAX

Aster yellows -- Some plantings in the Yaqui Valley were observed to be attacked by a virus disease tentatively identified as aster yellows virus.

BARLEY

Smut -- Ustilago spp. All three barley smuts were general throughout the Sonora barley areas. Losses, however, were comparatively light.

SAFFLOWER

Rust -- Puccinia carthami Cda. Was observed on one commercial planting near Ciudad Obregón, Sonora.

Root rot -- Root rot caused by Phytophthora sp. continues to be the principal disease attacking this crop in the northwest of Mexico. Replanting was necessary on some farms.

Mosaic virus -- A mosaic disease was quite severe on January plantings in the Yaqui Valley, Sonora. Subsequent plantings had less of the disease. All varieties are equally susceptible.

ALFALFA

Rust -- Uromyces striatus Schroet. var. medicaginis (Pass.) Arth. was fairly common throughout Mexico. In some seed production lots the disease incidence necessitated their being cut for fodder.

Downy mildew -- Peronospora trifoliorum D By. As is common every year, moderate attacks of this fungus were found throughout Mexico.

Black leaf spot -- Pseudopeziza medicaginis (Lib.) Sacc. Was found throughout the central plains (Bajio) and the Central Mesa. Damage was variable.

POTATOES

Late blight -- Phytophthora infestans (Mont.) D By. Was a serious problem in the important potato-growing areas of the Central Mesa (States of Puebla, Tlaxcala, México, Hidalgo, and Veracruz), and caused partial to total loss in a majority of fields. The total crop was reduced 25 to 30 percent. Late blight appeared for the first time in serious proportions in the Navidad area (State of Nuevo León).

Early blight -- Alternaria solani (Ell. & G. Martin) Sor. Widespread but of minor importance.

Rhizoctoniosis -- Rhizoctonia solani Kuehn. Reduced the stand 10 to 15 percent in the León winter planting. Elsewhere it was sporadic and of minor importance.

Punta morada -- (Virus). Again was widespread and ranks as No. 1 virus problem of potatoes in Mexico. Similar to the U. S. "purple top," it caused direct losses in the Bajío (State of Guanajuato) and affected the seed value of crops grown in the Central Mesa and at Navidad, Nuevo León.

BEANS

Because of the heavy rains in the principal bean-growing areas, diseases were important and widespread. The following diseases were observed:

Circular leaf spot -- Chaetoseptoria wellmanii Stevenson. This disease is becoming more important each year. In 1958 in the Central Mesa area, the Canario-type beans were almost completely defoliated by circular leaf spot. Fortunately, the main attack came after the pod set, so actual losses were not great. Investigations indicate that non-Canario genotypes carry resistance to this disease.

Rust -- Uromyces phaseoli (Reben.) Wint. This disease was widespread throughout the Central Mesa, Bajío, and the Gulf coast. The telial stage, rarely seen in Mexico, was noted widely in the Central Mesa.

Anthracnose -- Colletotrichum lindemuthianum (Sacc. & Magn.) Scrib. In spite of the continued wet weather, very little anthracnose was noted.

Bacterial blight -- Pseudomonas phaseolicola (Burkh.) Dows. and Xanthomonas phaseoli (E. F. Sm.) Dows. Both halo blight and common blight were widespread and damaging. The Canario-type varieties were particularly affected.

Stem rot -- Phytophthora parasitica Dast. This was seen in an experimental introduction plot at Chapingo, México, on plants originating from seed from Cuba. It is believed that this is the first authenticated report of the disease in Mexico on beans.

Sclerotinose -- Sclerotinia sclerotiorum (Lib.) D By. Again this year the disease was noted in localized areas of some fields. In one case the beans had been part of a 3-year bean, alfalfa, corn rotation.

Angular leaf spot -- Isariopsis griseola Sacc. This disease was seen again in the Gulf Coast areas and for the first time at higher altitudes in the Central Mesa.

Severe Bean Mosaic Virus -- A severe mosaic virus of beans was again observed in the Veracruz area. A description of the disease and the results of experimentation with this virus is in manuscript form for publication in another journal. Common mosaic and yellow mosaic were also observed in both snap and field beans in the tropics.

PEAS

Powdery mildew -- Erysiphe polygoni DC. This continues to be the principal pest of garden peas in the Central Mesa.

CALABACITAS (Cucurbita pepo L.)

Cottony leak -- Pythium aphanidermatum (Edson) Fitz. This disease was observed as a blossom end rot in summer plantings in the Central Mesa.

PEPPER

Southern bacterial wilt -- Pseudomonas solanacearum E. F. Sm. Probable bacterium isolated from wilted plants in experimental plot at Chapingo, México.

Blight -- Phytophthora capsici Leonian. In the Central Mesa this disease caused great losses, in some cases 100 percent of the planting on a given farm.

ONION

Downy mildew -- Peronospora destructor (Berk.) Casp. Seen throughout the Central Mesa. Damage only slight.

LETTUCE

Downy mildew -- Bremia lactucae Regel. Seen in market and in lettuce fields in the Central Mesa.

TOMATO

Damping-off -- Rhizoctonia solani Kuehn. Caused losses of 10 to 12 percent of small plants in the northwest winter tomato area.

Wilt -- Fusarium oxysporum Schlecht. f. lycopersici Sacc. Present but not of importance in the northwest tomato areas.

Early blight -- Alternaria solani (Ell. & G. Martin) Sor. Same as Fusarium wilt.

Late blight -- Phytophthora infestans (Mont.) D By. Present throughout the Bajio during the summer, causing great losses in tomato plantings.

CARROT

Leaf spot -- Cercospora carotae (Pass.) Solh. Prevalent in summer vegetable plantings in the Central Mesa.

Rots -- Rhizopus sp., Fusarium sp., and Rhizoctonia solani Kuehn caused some damage in over-irrigated plots in the northwest and during the summer plantings in the Central Mesa.

WATERMELON AND MELON

Downy mildew -- Pseudoperonospora cubensis (Berk. & Curt.) Rostow. In the Yaqui Valley, downy mildew was widespread in the spring. Most plantings seen were infected, although losses did not appear to be important.

Powdery mildew -- Erysiphe cichoracearum DC. Same as downy mildew.

Anthracnose -- Colletotrichum lagenarium (Pass.) Ell. & Halst. This disease was common and destructive throughout the Yaqui Valley.

ROCKEFELLER FOUNDATION MEXICAN AGRICULTURAL PROGRAM, AND OFFICE OF SPECIAL STUDIES OF THE MEXICAN MINISTRY OF AGRICULTURE AND ANIMAL INDUSTRY

EFFECT OF TARGET SPOT ON YIELD OF SOYBEANS[1]

Edgar E. Hartwig[2]

Leaf spotting of susceptible varieties and experimental lines of soybeans caused by target spot, Corynespora cassiicola (Berk. & Curt.) Wei, has been observed in all the southeastern States. In the Delta area of Mississippi susceptible varieties were infected each year from 1949 through 1958. Observations in 5 years, 1949, 1950, 1951, 1957, and 1958, suggest that losses from target spot in experimental plantings ranged from 18 to 32 percent. Rainfall during August and September of the other 5 years was below normal, and the disease did not develop sufficiently to cause defoliation. The estimates of losses reported were obtained from natural infections. Nearly all of the soybean acreage in the Delta area is planted with varieties resistant to target spot. The results reported emphasize the value of this resistance.

The estimates in 1949 and 1957 were based upon comparative yields of resistant and susceptible varieties known to produce comparable yields when the disease was absent or present in small amounts. In 1949, two highly susceptible varieties produced 30 percent less than resistant varieties at Stoneville, Mississippi. In 1957, susceptible varieties averaged 18 percent less than resistant varieties at Stoneville.

In 1950, a group of advanced lines from the cross Roanoke x a selection from Ogden x CNS were evaluated in a replicated planting. All these lines had been selected for resistance to bacterial pustule, lodging, and shattering. None of them had previously been evaluated for seed yield or target spot reaction. Target spot development was heavy on lines which proved to be susceptible. The group included 42 lines classed as resistant to target spot and 19 lines classed as susceptible. The mean yield of the 42 resistant lines was 43.5 bushels per acre, while that of the 19 susceptible lines was 30.8 bushels per acre. Susceptible lines averaged 29 percent lower in yield than the resistant lines. Three resistant and three susceptible lines similar in growth type and maturity were selected for further testing in 1951 and 1952. In 1951, there was a moderately heavy development of target spot, while in 1952 infection was light. Results of these plantings are reported in Table 1.

During the 1958 season, a group of advanced F_5 lines from the cross Roanoke x D49-2491[3] were evaluated at the Delta Branch of the Mississippi Agricultural Experiment Station with one replication planted on a Bosket fine sandy loam on May 14 and the other replication planted on a Sharkey clay on May 29. A heavy target spot infection developed on susceptible lines on the sandy loam field, while infection was light on the clay field. Three resistant selections, Jackson, Lee, and D49-2491, were each repeated four times on each soil type. Their mean yield on the sandy loam was 42.5 bushels versus 42.0 bushels on the clay. Thirty-one lines were given low ratings for target spot. Their mean yields were 39.2 bushels and 39.7 bushels per acre, respectively, for the sandy loam and clay fields. Results from the check varieties and 31 resistant lines indicate that the yield levels for the two soil types were nearly equal. Twenty-one susceptible lines yielded at the rate of 28.3 bushels per acre on the sandy loam, where they were heavily infected with target spot, and at the rate of 41.6 bushels per acre on the clay, where they had only a light infection. These results, which are summarized in Table 2, would suggest a yield reduction of 32 percent from target spot.

Target spot is considered to be a potentially more serious disease of varieties maturing during October, or later, in this area than of earlier maturing varieties. Disease lesions are seldom observed prior to mid-August. Disease development increases after that time, if conditions are favorable. Highly susceptible varieties may be nearly defoliated 3 weeks prior to normal maturity. Drouth stress during this period retards disease development.

Defoliation studies conducted at Stoneville showed a yield reduction of 29 percent when all leaves were removed 21 days prior to normal maturity and a yield reduction of 17 percent when all leaves were removed 14 days prior to normal maturity. The yield reduction from target spot seems to approximate the yield reduction to be expected from the defoliation which it causes.

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[1]Studies were conducted by the U. S. Regional Soybean Laboratory in cooperation with the Delta Branch of the Mississippi Agricultural Experiment Station.

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[3]D49-2491 is an experimental line used in the breeding program at Stoneville, Mississippi. It is a selection from S-100 x CNS and is closely related to the Lee variety.

Table 1. Seed yield per acre of soybean lines differing in reaction to target spot and grown in seasons in which target spot development on susceptible lines differed.

Disease reaction and line designation	1951[a]	1952[b]
Resistant Line A	40.4	39.0
Resistant Line B	44.9	42.5
Resistant Line C	44.6	40.9
Mean	43.3	40.8
Percent[c]	100	100
Susceptible Line D	35.5	41.3
Susceptible Line E	34.8	40.4
Susceptible Line F	32.7	43.1
Mean	34.2	41.6
Percent[c]	79	102

[a]With moderately heavy target spot development on susceptible lines, differences between groups were highly significant (odds greater than 99:1), but differences within groups were nonsignificant.
[b]With light target spot development on susceptible lines, differences between and within groups were nonsignificant.
[c]Seed yield of resistant lines expressed as 100 percent, and seed yield of susceptible lines expressed as a percentage of the yield of resistant lines in each year.

Table 2. Yields per acre and percentage relationships of soybean lines differing in reaction to target spot and grown in two fields at Stoneville, Mississippi in 1958 where the degree of target spot development differed.

Disease reaction	Field 1 - heavy target spot development		Field 2 - light target spot development	
	Bushels/acre	Percent[a]	Bushels/acre	Percent[a]
3 resistant checks	42.5	101	42.0	100
31 resistant lines	39.2	99	39.7	100
21 susceptible lines	28.3	68	41.6	100

[a]Seed yield of lines grown on Field 1 expressed as a percent of yield for same lines grown on Field 2. Yield of each group on Field 2 considered as 100 percent.

All observations reported were based upon natural infection. The results reported for 1949, 1950, 1957, and 1958 were from soybeans growing in a 3-year rotation of soybeans, corn, and cotton. The 1951 and 1952 results were from an area where soybeans were being grown continuously. The results obtained suggest that resistant varieties are the most practical means of avoiding losses from target spot and that a 3-year rotation of soybeans, corn, and cotton is of little, if any, value from the standpoint of target spot control.

CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

THIELAVIOPSIS BASICOLA, A PART OF THE COTTON (GOSSYPIUM HIRSUTUM) SEEDLING DISEASE COMPLEX IN NEW MEXICO [1]

E. E. Staffeldt[2]

Abstract

The black root rot causal organism, Thielaviopsis basicola, was common in most upland cotton-producing areas of New Mexico. This organism was isolated primarily from tissues located at or below the soil line and was more frequently found invading plants grown in clay than sandy soils. Fields varied from 0 to 100 percent infected plants. Under New Mexico conditions upland cotton stands were not affected but the growing season was reduced. Very few plants exhibited internal infection. All the genetic lines examined were susceptible and tolerated the invasion by T. basicola, but later exhibited a high degree of active pericyclic resistance.

Seedling diseases have plagued the New Mexico farmers and farmers throughout the cotton belt. Damage due to this type of malady is expressed in the form of seed rot, pre- and post-emergence damping-off, seedling root rot and "sore shin."

Sherbakoff (6) in 1940 reported the occurrence of Thielaviopsis basicola on American-Upland cotton seedlings grown in the greenhouse. King and Presley (2) described seedling symptoms on cotton in 1942 and Presley (5) reported the occurrence of and damage caused by this organism under field conditions. He observed reduction in stand resulting from the killing of cotton seedlings by T. basicola. The occurrence of the black root rot organism on mature American-Egyptian cotton in New Mexico was reported by Leyendecker (3) in 1952 and by Leyendecker and co-workers (4) in 1953. Later in 1953, Blank, Leyendecker and Nakayama (1) reported their observations of black root rot on American-Egyptian cotton seedlings grown in the greenhouse. Thielaviopsis basicola had not commonly been associated with diseases of upland cotton seedlings in New Mexico.

The effect of various crops and the incorporation of their residues on the seedling disease complex led to a short-term crop rotation study in the greenhouse during the winter of 1953-54. Following the growth of the rotation crops in pots containing local field soil, the incorporation and decomposition of their residues, upland cotton seeds were planted to all pots. Cotton seedlings were removed after 4, 5, 7 and 11 weeks of growth. One hundred percent of the seedlings' roots exhibited external symptoms, regardless of the rotation crop incorporated. Root rot readings taken indicated no differences due to the crop incorporated (Fig. 1). These crops included cotton, barley, barley-Hubam, Hubam, black-eyed peas, and soybeans. In addition to these treatments a check, a soil treatment of composted gin trash and a sterilized check were included. Black root rot was as apparent on roots of plants grown in the check and soil amendment as it was on plants in the rotations, but was not isolated from roots of seedlings grown in the sterilized soil. External symptoms were found on seedlings after 4 and 5 weeks of growth. The removal of plants after the seventh week indicated some recovery from the attack. By the eleventh week the cotton plants were almost completely recovered.

In the spring of 1954 attention was focused on the appearance of T. basicola as a seedling disease of upland cotton under New Mexico field conditions. An extensive amount of tissue from what appeared to be diseased cotton seedlings was plated to determine the presence and prevalence of this organism. These plants were obtained from four cotton-growing areas in New Mexico (Dona Ana to Anthony, Roswell to Artesia, Hatch and Deming) and one area in Texas (Ysleta). The organism was frequently isolated from cotton roots grown in the first three listed New Mexico areas and the one Texas area, but was not isolated from cotton roots from the Deming area. Within these five locales, 57 fields were sampled and 1180 pieces of tissue were plated from the cotton roots. Thielaviopsis basicola was observed growing from

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FIGURE 1. Severity of infection of American-Upland cotton seedling roots by Thielaviopsis basicola. Left to Right: Severe, Moderate, Slight, Trace and Healthy.

FIGURE 2. Field grown cotton seedlings infected with and recovering from attack by Thielaviopsis basicola. Left to Right: Healthy 4-week-old seedling; two diseased 4-week-old seedlings; recovering 7-week-old seedling; recovering 8-week-old seedling; and recovered 11-week-old seedling.

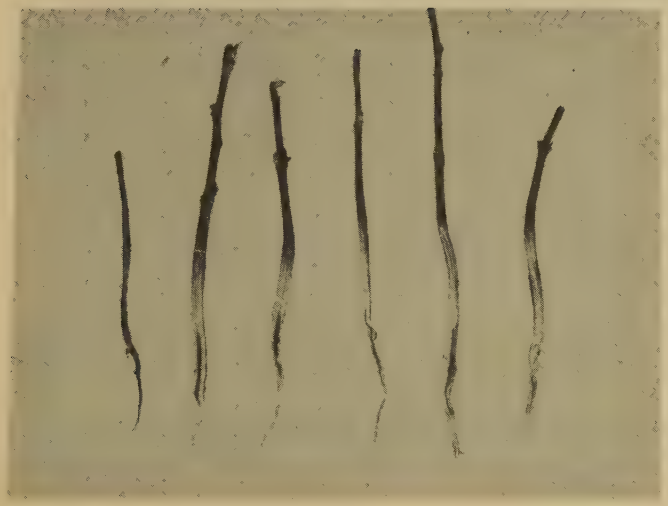

FIGURE 3. Internal infection of upland seedling cotton plants. This condition was not a common occurrence in upland seedlings.

447 of these tissues. The black root rot organism grew primarily from tissues located at or below the soil line. Seldom was this organism isolated from seedling tissue above the soil line. Thielaviopsis basicola was more prevalent on plants grown in heavy-clay soils. Individual fields ranged from 100 percent infected plants on heavy soils to no infected plants on sandy soils. Isolations from long staple cottons were similar to those from upland cottons.

Thielaviopsis basicola penetrated the epidermis of the root, ramified through and destroyed the cortical tissue. All observations and experimentation conducted by this author thus far have indicated that the cotton plants were tolerant to invasion by T. basicola. No death of cotton plants due to this organism was recorded under the environmental conditions prevailing in New Mexico during the growing seasons. The infected seedling roots remained in this diseased condition for 2 to 4 weeks. After this time, meristematic activity in the pericycle produced periderm tissue that replaced the destroyed epidermis and cortex. Within 2 to 3 additional weeks the external symptoms were visible as black streaks of tissue being sloughed off. This continued until the root appeared perfectly healthy externally (Fig. 2).

Infection beyond the endodermis was rarely found in Gossypium hirsutum seedlings. Of the thousands of seedlings removed and examined a few exhibited internal symptoms as shown in Figure 3.

During the spring of 1955 observations were made and data were obtained from 208 rows of cotton of diverse genetic background. This material was grown in a field of heavy clay soil and was rated as containing 100 percent infected plants the previous year. Every plant removed during the first 9 weeks of plant growth had black root rot. Only slight differences were recorded as to severity on the various genetic lines. All were susceptible. On May 30, 1955 plants in 111 rows were completely recovered, plants in 95 rows exhibited major recovery and plants in the final two rows showed minor recovery. Recovery continued until the final reading on June 21, 1955, at which time cotton plants in 206 of the 208 rows were completely recovered and the remaining two rows of plants exhibited major recovery. Cotton plants that damped-off during this time were removed and isolations were made. Rhizoctonia solani was the primary isolate obtained.

Thielaviopsis basicola was not important in the reduction of stands of cotton under the environmental conditions that exist in New Mexico. Therefore, the application of in-furrow treatments to control Rhizoctonia solani would greatly assist cotton farmers to obtain and maintain stands. The black root rot organism was important in reducing the growing season by 2 weeks. This was the time necessary to initiate meristematic activity and the utilization of food materials in the formation of tissues to replace the destroyed epidermis and cortex. In an area where a short cotton growing season already prevails this could be a serious problem. The other effect this organism produced was the avenues of entrance it opened for other soil-borne organisms. Verticillium albo-atrum, wilt disease of cotton, has been isolated from roots that had been previously attacked by Thielaviopsis basicola.

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PHYSALIS ALKEKENGI L., A NEW HOST FOR THE U. S. COTTON-, CASSIA-, AND SWEETPOTATO-WILT FUSARIA[1]

J. K. Armstrong and G. M. Armstrong[2]

Repeated attempts by the writers to inoculate the Irish potato with its wilt Fusarium (Fusarium oxysporum Schlecht., or F. oxysporum Schlecht. f. tuberosi Snyder & Hansen) have given erratic results which are similar to those reported by others. In an effort to find a host other than the potato plants of different genera and species of the Solanaceae were grown. Among these was Physalis alkekengi L., winter cherry or the Chinese latern plant. Although this plant was not susceptible to the potato Fusarium, its susceptibility to several other wilt Fusaria is the subject of this report.

METHODS

The methods used in the investigation of the wilt Fusaria have been given elsewhere (1) and will not be repeated in detail. Seed were sown in flats of steamed sand, and the plants were given a nutrient solution until they were about 5 inches tall, at which time they were removed for inoculation. At this stage the plants had an extensive root system and were easily transplanted. After the rhizomes and some of the roots were clipped with sterilized scissors, the basal portion of the plant was dipped in the fungus inoculum, and six to eight plants were set in steamed sand in 2-gallon glazed pots. A second inoculation was given 7 to 10 days later by cutting the roots toward the center of the pot with a large test tube, pouring 500 ml of the liquid inoculum on the cut roots, replacing the sand, and watering the pot with 200 to 300 ml of tap water. All inoculations were made in the late afternoon, and usually by the following morning the plants had recovered from the shock of transplanting and root injury; those that had not were shaded temporarily. The experiments were terminated about 2 months after the first inoculation. Reisolations of Fusaria were made from diseased plants in the inoculation experiments by plating surface-sterilized stem sections on water agar. Inoculations were made on the appropriate host to establish the identity of these isolates.

RESULTS AND DISCUSSION

Most of the plants inoculated with the isolates from Cassia; cotton, races 1 and 2; and sweetpotato, race 2 were dead or severely wilted when the experiment was terminated (Table 1). However six plants, in each of two pots, inoculated with different isolates of race 1 of the sweetpotato Fusarium were either free of symptoms or very slightly affected, except for one severely diseased plant in each pot.

Thus Physalis and the Gold Dollar variety of flue-cured tobacco reacted alike to races 1 and 2 of the sweetpotato-wilt Fusarium, that is, susceptible to race 2 but resistant or only slightly susceptible to race 1 (3). In contrast, Physalis was very susceptible to both races of the U. S. cotton-wilt Fusarium, whereas Gold Dollar tobacco was resistant to race 1 and susceptible to race 2 (4). Another difference was the high susceptibility of Physalis, as contrasted with the high resistance of flue-cured tobacco, to the wilt Fusarium from Cassia.

Furthermore Physalis, like alfalfa (2), was very susceptible to the U. S. cotton and Cassia Fusaria, thus establishing another common host for these organisms. However, the Egyptian and Indian cotton-wilt Fusaria did not cause wilt of Physalis (Table 1) or alfalfa (2). The reaction of Physalis was of interest also since no other common host for the Cassia- and sweetpotato-wilt Fusaria has been reported.

Twelve different isolates of the Irish potato-wilt Fusarium were nonpathogenic on a total of 125 plants of Physalis in 17 pots. Also there were no symptoms of wilt when five to eight plants per pot were inoculated singly with each of the following virulent isolates of wilt Fusaria from: asparagus; aster; bean; beet; cabbage, race 1; celery; cowpea, races 1 and 2; cucumber; mimosa, race 1; muskmelon; pea, race 2; sesame; spinach; stock; sumac; tomato, races 1 and 2; and watermelon.

[1]Contribution of the Department of Botany and Bacteriology in cooperation with the Cotton and Cordage Fibers Research Branch, Crops Research Division, Agricultural Research Service, United States Department of Agriculture. Technical Contribution No. 308, South Carolina Agricultural Experiment Station.

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Table 1. Results of inoculations of Physalis with alfalfa-, cassia-, cotton-, and sweetpotato-wilt Fusaria.

Fusarium isolate	Number of plants inoculated	Number of plants with external symptoms of wilt	External symptoms (percent)	Remarks
U. S. cotton, race 1	12	10	83.3	
U. S. cotton, race 2	7	7	100	Isolate from flue-cured tobacco.
Cotton, Egypt	10	0	0	
Cotton, India	6	0	0	
Sweetpotato, race 1	12	7	58.3	5 of the 7 plants with slight symptoms.
Sweetpotato, race 2	26	23	88.5	Isolate from flue-cured tobacco.
Cassia	51	50	98.0	
Alfalfa	6	0	0	
Uninoculated checks	18	0	0	

Literature Cited

1. ARMSTRONG, G. M., and J. K. ARMSTRONG. 1948. Nonsusceptible hosts as carriers of wilt Fusaria. Phytopathology 38: 808-826.
2. ARMSTRONG, G. M., and JOANNE K. ARMSTRONG. 1954. Alfalfa -- a common host for the wilt Fusaria from alfalfa, cotton, and Cassia. Plant Disease Reptr. 38: 221-222.
3. ARMSTRONG, G. M., and J. K. ARMSTRONG. 1958. The Fusarium wilt complex as related to the sweetpotato. Plant Disease Reptr. 42: 1319-1329.
4. ARMSTRONG, J. K., and G. M. ARMSTRONG. 1958. A race of the cotton-wilt Fusarium causing wilt of Yelredo soybean and flue-cured tobacco. Plant Disease Reptr. 42: 147-151.

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A NEW DISEASE RECORD IN THE U. S. AND NEW LOCATIONS FOR A WELL KNOWN DISEASE

CERCOSPORA ANTIRRHINI FOUND IN FLORIDA

By Joseph H. Bolick[1]

On October 17, 1958 a planting of Antirrhinum majus was inspected in Ormond Beach, Florida and a leaf spot noted on many of the plants. Further investigation revealed a species of Cercospora fruiting in the leaf lesions. Examination of the fungus led to its tentative identification as Cercospora antirrhini Muller & Chupp. Material was forwarded to Dr. Charles Chupp of the Department of Plant Pathology, Cornell University, Ithaca, New York, who confirmed the identification and stated that he believed it to be the first report of this fungus in the United States.

Chupp, in his A Monograph of Cercospora, published in 1953, gave the type locality as Guatemala and the year it was found as 1943. He described the lesions as circular, 0.5 to 5 mm in diameter, dingy gray to white, narrow raised brown line border; fruiting amphigenous. This description agrees with the symptoms observed in Florida.

Preliminary mycelial inoculations indicate that the fungus does infect the leaves via stomatal openings and that typical lesions are formed, with abundant amphigenous sporulation occurring after 2 to 3 weeks.

Infected leaves have been deposited in the Florida Agricultural Experiment Station Herbarium under #F-49553.

Figure 1 shows the disease on Antirrhinum majus.

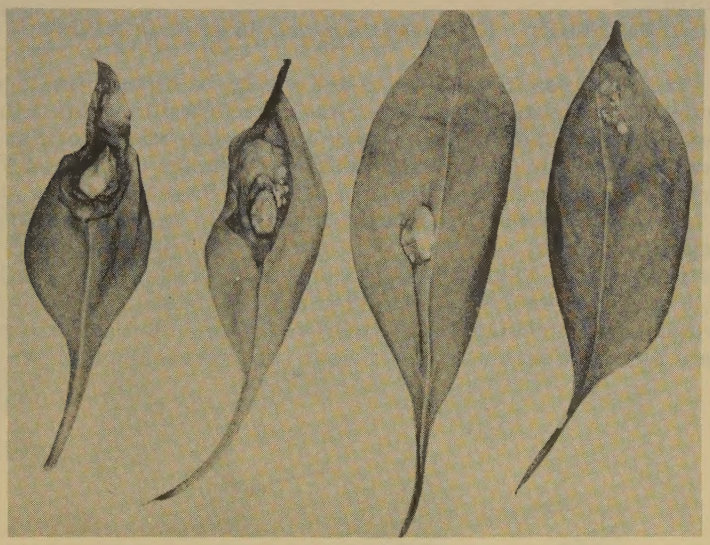

FIGURE 1. Cercospora antirrhini Muller & Chupp on Antirrhinum majus (State Plant Board of Florida photo by Jerry Messec.)

STATE PLANT BOARD OF FLORIDA, GAINESVILLE, FLORIDA
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DUTCH ELM DISEASE IN KANSAS IN 1958

By C. L. Kramer[1] and Hugh E. Thompson[2]

Since the discovery of Dutch elm disease (Ceratocystis ulmi) in Kansas in October 1957 from Wyandotte and Johnson counties[3] twelve additional locations of the disease have been found in these and surrounding counties during 1958. The positive locations now include four new locations in Wyandotte County (1 collection June 6, 1958; 2 collections June 9, 1958; 1 collection by the Renfro Tree Service, Kansas City, Kansas, on July 1, 1958); one new loca-

tion in Johnson County (July 8, 1958); five locations in Leavenworth County (1 collection June 9, 1958; 4 collections on September 8, 1958); and two locations in Miami County (1 collection by Lyle Weeks, July 7, 1958; 1 collection September 8, 1958). This makes a total of 15 locations in the four counties in Kansas bordering Kansas City, Missouri, where the disease had been reported earlier. The collections were made by Dr. Hugh E. Thompson except where otherwise indicated, while the isolations and identifications were made by Dr. C. L. Kramer.

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[3]Pady, S. M. 1958. Dutch elm disease in Kansas. Plant Disease Reptr. 42: 402.

CORRECTION

REPORTER, Supplement 254 (February 15, 1959). The authors wish to correct some errors they made in their original manuscript, as follows:

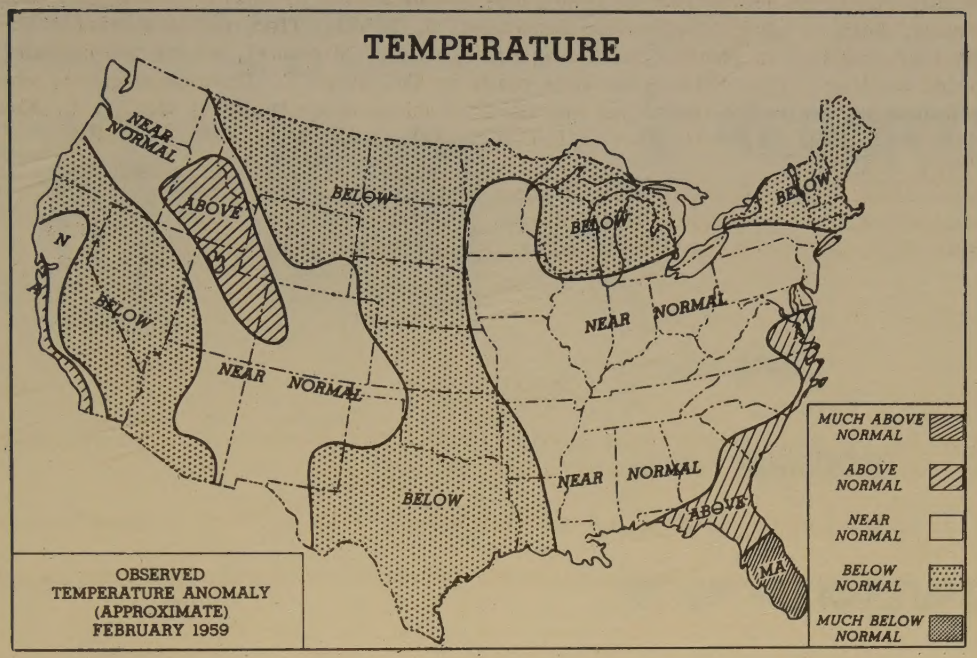
page 13: In the Summary, third line from the bottom, change "27 of 36 trees" to read "28 of 36 trees"

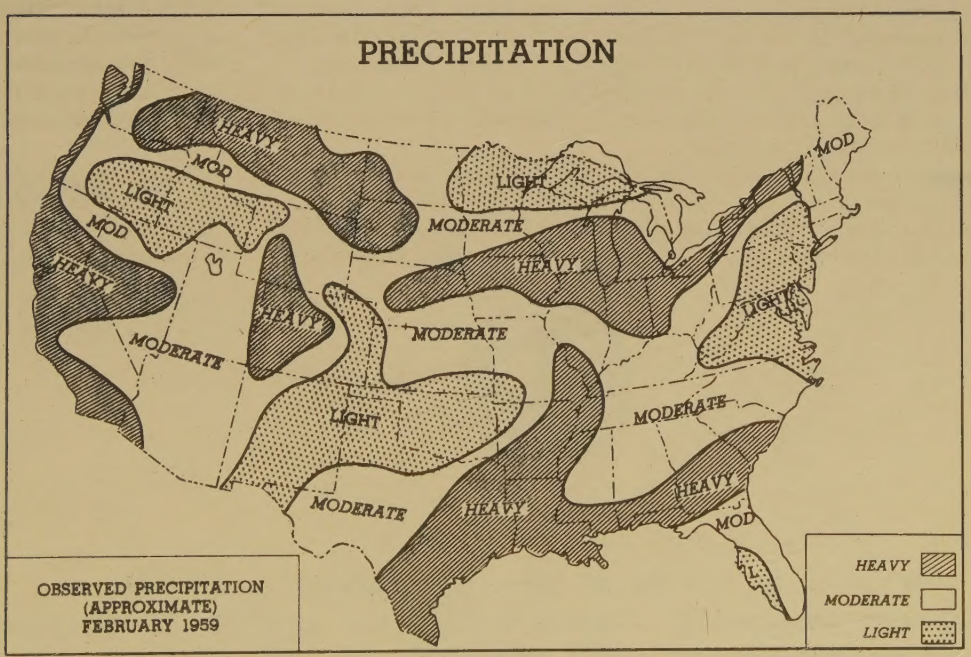
page 13: at bottom of page, the plant introduction number of Antonovka Funtovaja should be 231295, not 231925.

page 17: under DISCUSSION. The discussion should read as follows:

"The Russian varieties used in these tests are worthy of further trials as sensitive indicators of the stem-pitting virus. In the experiment recorded in Table 2 the stem pitting symptoms appeared in the Russian indicators within 4 months after inoculation. In the indexing trials of 36 trees recorded in Table 3 the Russian seedlings expressed the stem pitting symptoms in 28 cases, whereas the K-6 clone of Virginia Crab so far has shown stem pitting symptoms only in 14 cases. Further, the Russian seedlings are the only known indicators of the chlorotic leaf spot syndrome.

"In the results recorded in Table 3 the chlorotic leaf spot and stem pitting symptoms are associated (either in presence or absence) in 32 of the 36 cases. The two syndromes were associated in indicator trees inoculated with buds of 28 of the 36 trees indexed. Experiments designed to elucidate the relationship between these two diseases are in progress."





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.